Using Model Eliciting Activities in a Dynamics Course

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Abstract

Typical assignments in a traditional dynamics course often do little to motivate students or to give them an indication of how they would use the material in a future job situation. Many instructors are now attempting to provide motivational projects, hands-on demonstrations, and even laboratory assignments to increase understanding and motivation. To help provide motivation and real-world context in our dynamics courses at California Polytechnic State University San Luis Obispo, we have implemented three model-eliciting activities (MEA). Model-eliciting activities (MEAs) originated in the math education community. They focus on the process of problem solving and model development, rather than just a final answer.

The first MEA requires students to create an Accident Reconstruction Procedure for police officers in Sri Lanka. The student teams were given four accident reports, some pulled from actual police reports, to analyze and use in determining their procedures. They had to utilize work-energy and momentum principles as guidelines, in addition to accounting for uncertainty and other noise in the data. Their Model Documentation was in the form of a memo to the Sri Lankan Police Chief, along with their analysis of the four accidents.

The customer for the second MEA is a publishing company of dynamics textbooks. The student teams had to develop guidelines to send to potential developers of online multimedia example problems. Their "Engineering Consulting Firms" then had to develop one of these multimedia examples according to their guidelines. The final MEA involves a physical experiment in which students have the opportunity test the validity of their work. The student teams are asked to analyze a catapult to help with an historical battle re-enactment in England.

Background to Model Eliciting Activities

MEAs, also called Thought Revealing Activities, were first developed in the mid 1970s to serve as a tool for understanding the problem solving thought processes of children studying mathematics [2]. Rather than pushing students toward a particular solution, MEAs focus on the development of an adaptive problem solving strategy or model that can be repeatedly used. The originators of MEAs propose six primary principles to develop new problems [1].

1) The Model-Construction Principle requires that the students come up with a procedure for explaining a "mathematically significant" situation.
2) The Reality Principle puts the problem in context and offers a client who needs a realistic engineering solution to a problem.
3) The Self-Assessment Principle enables students to analyze their problem solutions and revise their approach to open ended problems.

4) The Model Documentation Principle teaches students to create a mental model of their process in solving the problem. Documentation of their model and solution is often in the form of a memo to the client.
5) The Generalizability Principle asks students to develop models that other students (and the client) could easily use, and models that can be adapted to other similar situations.
6) The Effective Prototype Principle states that the concepts students must formulate, construct, and modify must be robust in terms of their applicability to the future academic and professional life of the engineering students.

MEAs have since been adapted for use in the engineering sciences as a way of introducing students to the types of open-ended scenarios that will be encountered outside of an academic setting in a job environment [3]. This is thought to provide a more motivating and memorable experience for students in place of doing a multitude of redundant textbook problems. Additionally, MEA's are used to help in identification and repair of student misconceptions in mechanics and thermal science [4].

Cal Poly San Luis Obispo has been involved in the collaborative research effort of incorporating MEAs into the mechanical engineering coursework since September 2007, and has since implemented MEAs in both thermodynamics and dynamics courses. We also currently have plans to expand the use of MEAs to other areas of the mechanical engineering curriculum.

The three MEAs that have already been implemented in the dynamics courses each provide a real-world context for doing dynamics work. They are intended to help incite motivation and stimulate model building thought. For each MEA, a small team of students was asked to develop a model or set of guidelines using dynamics principles in response to a client's specific needs. Students were also asked to document their model, either in a memo or short report, and provide one or two examples of how the model is utilized. At the end of the academic quarter, the dynamics students that took the MEAs were asked to complete a comprehensive survey that included questions about whether each project motivated them to participate in class and if the MEAs helped them learn material regarding the class.

Accident Reconstruction MEA

The first MEA implemented in the course involved creating a procedure for investigating traffic accidents where one party was potentially speeding. In order to provide a meaningful social context for the scenario, the problem statement was presented in the form of a memo from the Inspector General of the Sri Lanka Police Service who is looking to both expand and modernize his department. Included with the memo were four sample accident case reports that the student teams used to develop their model. Some of the case reports were adapted from actual reports provided by the Oceanside Police Department, in Oceanside California, which added a unique level of both realism and ambiguity to the project. The remaining reports were fabricated to mirror the authentic reports provided by the police department, and were written utilizing similar language and formatting. Table I below outlines how the Accident Reconstruction MEA meets each of the six primary principles.

TABLE I
THE ACCIDENT RECONSTRUCTION MEA DESIGN PRINCIPLES

MEA Design Principles	**How the Accident Reconstruction MEA meets the design principle**
Model Construction	Each team will produce a protocol to provide to new traffic investigators based on the solutions of several accidents.
Reality	Dynamics calculations in accident reconstruction are an essential part of forensic engineering. Additionally, the social context of the expanding Sri Lanka Police Service is an actual current event.
Self-Assessment	The provided case reports are intended to be a way in which students can test their model. Because most of the cases are actual incident reports, courtesy of the Oceanside Police Department, conclusions can be compared to those of the investigating officers.
Model Documentation	Teams will write a memo explaining their method for accident analysis. Included with the memo will be a written protocol that an officer can use at the scene and the conclusions of their analysis of each provided incident report.
Generalizability	The model that students will create must be usable for all of the provided incident reports. It should also be able to be easily adapted for analyzing other traffic accidents.
Effective Prototype	Formulating a model requires students to utilize principles of work-energy and momentum, which will be encountered in future academic and professional work. The MEA also requires them to work with energy lost in an inelastic collision in the form of vehicle crush constants

The MEA was presented to students in the third week of instruction, after students were introduced to the concepts of work-energy and collision momentum. Teams of four were given one week to complete the project, during which they were allowed to email their professor for some select additional information not provided in the MEA, such as coefficient of friction values, posted speed limits and vehicle crush constants.

Overall, students enjoyed the MEA. End of the year survey data showed that 60% of students agreed that the project helped them learn the principles of work-energy and momentum, 9% of which felt strongly about the results. Additionally, 61% of the students surveyed felt that the project was interesting and motivating. Most of the students seemed engaged by working on a problem that related to a realistic setting; those who were not, appeared to be detoured by the open-endedness and uncertainty associated with the case reports.

Multimedia Example MEA

The second MEA was not necessarily designed to focus on any particular dynamics topic, but rather to gain more insight into what students think is important for effectively learning from an example problem. In the MEA, they were asked by a textbook publisher to create specific guidelines for dynamics professors that can be used to develop online multimedia example problems for a dynamics class. Throughout the course, students were required to view several interactive online example problems prior to coming to class, and most had already had exposure to other online examples available from several textbook publishers. The following table lists the MEA's adherence to the six principles.

TABLE II
THE ONLINE MULTIMEDIA MEA DESIGN PRINCIPLES

MEA Design Principles	How the Online Multimedia MEA meets the design principle
Model Construction	Each student team must develop specific guidelines for creating dynamics example problems, including one sample example problem made using these guidelines
Reality	Textbook publishers are more frequently offering some sort of online multimedia support for their books. Most students have already had experience with textbook support sites.
Self-Assessment	By creating a sample dynamics example problem students are able to test if their guidelines work in practice.
Model Documentation	Teams will write a memo to the client with their guidelines for professors to use along with the sample problem.
Generalizability	The guidelines that students will create should be capable of being used for developing example problems for any of the concepts covered in a typical dynamics course.
Effective Prototype	The models students create should help them conceptualize their own thought processes when reviewing example problems and will aid them in their continued education.

The Multimedia MEA was presented to students in the sixth week of classes. As with the Accident Reconstruction MEA, students worked in teams of four and were given one week to complete the assignment, which they later presented in class.

Student feedback for this project was mixed. 36% of students responded that the project helped them understand the dynamics material, while 30% disagreed; the remaining 34% had no had no opinion either way. Responses about project motivation had similar results, with 39% of students feeling that the project was motivating and 40% disagreeing. While the MEA required students to focus on developing a thought process for explaining a problem, it is possible that they spent too much time concerned about the aesthetics of their example rather than honing their model. To eliminate this, we have limited the example to one rigid body dynamics problem and are providing specific instructions on how do the online examples in PPT.

Catapult Design MEA

The last MEA asked students to create a procedure for determining the launch settings of a catapult given a specific target distance. The client for this MEA was the Peterborough, England City Council, who sponsors an annual interactive medieval exhibition at the Peterborough Museum Art Gallery. The actual event currently includes a trebuchet competition in which participants build and fire their own trebuchets. In lieu of this, the MEA presented the scenario that the City Council desired to expand the event to include a catapult demonstration. Students were given the opportunity to take dimension measurements from one of several mini catapults, seen in figure 1 below, and a digital force gage was used to acquire the rubber band tension at varying lengths. The procedures that students were required to create needed to account for varied settings such as pin locations and pull-back angle, and to explain possible sources of error. Finally, students were allowed to test their model's ability to predict the projectile's distance by firing raw eggs at a picture of their professor (for a fun hands-on experience). Table III below shows how the six MEA principles are met by the project.

Figure 1: The Statapult, designed as a Six Sigma quality management training device available for purchase online.

TABLE III
THE CATAPULT MEA DESIGN PRINCIPLES

MEA Design Principles	**How the Catapult MEA meets the design principle**
Model Construction	The student teams will produce a methodology to provide to Physics instructors, including a mathematical solution for a single catapult setting.
Reality	The Peterborough Museum Art Gallery holds an annual Medieval Machines exhibition that includes a trebuchet competition. Cal Poly has purchased several of the catapults, therefore the students can actually launch the catapults afterwards to test their calculations.
Self-Assessment	The teams will be provided data regarding maximum distances that the catapult can fly, which they can then use to test their calculations. Alternatively, they could simply be told a range of distances by which they can assess their calculations on launch day.
Model Documentation	Teams will produce a memo to the client detailing the procedure to estimate the launch distance. Sample calculations are also required. Students may choose to provide an Excel spreadsheet or other computer program to make the model more usable for the client.
Generalizability	The teams must create the model for the city council to use for a variety of different configurations. The catapult operators may want to change the number of rubber bands, the placement of the different pins, or the mass of the projectiles. The general approach may be applicable to other models of catapults (the company also makes a Trebuchet catapult).
Effective Prototype	Basic concepts of work-energy and projectile motion are used in the MEA. Students could also choose to apply concepts of angular momentum or even variations of Newton's Second Law. The teams will apply theoretical dynamics principles to a practical application that they can actually test in a hands-on "experiment".

This was the last MEA presented to students during the ninth week of the academic quarter. Again, students were placed in groups of four. They were given one week for their analysis and procedure development, and then performed testing the following week.

A total of 68% of the students thought the MEA was interesting and motivating. Additionally, 49% of students felt that the MEA helped them learn the material, 20% of that group feeling that it helped them very strongly. The main complaint that students had about this project was that it was presented too late in the quarter and they would have liked more time for completion.

Conclusions

The MEAs utilized in the dynamics courses were all aimed at motivating students by providing realistic and interactive scenarios that were client driven, and by giving them the chance to develop higher levels of problem solving conceptualization than typical textbook problems allow. With each MEA tested valuable feedback was gained on how to better meet the educational needs of students. In general, the two projects with more direct correlations to material covered in lecture, the Accident Reconstruction and Catapult MEAs, appeared to be more successful with students. Those who did not feel motivated by the MEAs typically cited that the scope of the projects were too large or that more time would be needed to better their models.

Future testing at Cal Poly will include expanding MEAs to statics and thermal systems design courses. Additionally, there are plans to add more incident reports to the Accident Reconstruction MEA to limit the likelihood of students dividing the four cases between them, forcing the students to operate more as a team. Moreover, this will give students a wider variety of scenarios that their procedure must be able to accommodate. There are also plans to enhance the self-assessment aspect of the Catapult MEA by instrumenting the mini catapult with strain gages and a two-axis accelerometer so that students can verify their calculations during their launches.

Acknowledgements

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Author Information

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Teresa Ogletree is an Undergraduate student at California Polytechnic State University, San Luis Obispo. She will be completing her bachelor's degree in Mechanical Engineering in March 2009.

Brian Self, California Polytechnic State University
Brian Self has been an Associate Professor at Cal Poly for the last three years. Before that, he taught at the Air Force Academy for seven years. He is the ASEE Campus Rep and the Zone IV Chair. Besides his pedagogical research, Dr Self is actively involved in aerospace physiology and biomechanics research. He has worked extensively to involve undergraduates in his research, taking students to present at national and international conferences. By involving students in solving ill-defined projects and problems that don't have a "correct answer", Dr Self hopes to further advance their intellectual curiosity and problem solving skills.

James Widmann, California Polytechnic State University
Jim Widmann is an Associate Professor of Mechanical Engineering at California Polytechnic State University, San Luis Obispo. He received his Ph.D. in 1994 from Stanford University. Currently he teaches mechanics and design courses. He conducts research in the areas of design optimization, machine design, fluid power control and engineering education.

Appendix A: Accident Reconstruction MEA

Memorandum

To: Forensic Engineering Team

From: H. M. B. G. Kotakadeniya, Senior Deputy Inspector General of Police, Sri Lanka Police Service

RE: Traffic Accident Reconstruction Protocol

Priority: [Urgent]

Since 2003 your country has been making large aid efforts toward development and economic stabilization here in Sri Lanka. Relations have gotten even closer with the invaluable help we received following the devastating tsunami in 2004. As a result, we have been able to become an important figure in the fight against terror in South-Central Asia.

As you may already know, the Sri Lanka Police Service has recently launched a new programme to update and modernize the service we provide to the public. One key area for improvement is in the Traffic Police Division. This division was established in 1953 to assist in making decisions on traffic policies and implementing them. Every currently existing station maintains a traffic branch, but the growing number of drivers on the island and the intended building of new stations demand that we immediately improve our accident investigation protocol. I am charging you with the task of compiling a new set of forensic engineering guidelines that can be used to train new police officers.

At the moment the main focus of this development must be in developing a procedure for determining if a driver has violated the speed limit. This procedure should use engineering principles to carefully guide our new investigators through the process of determining whether the driver in question has indeed caused the accident by speeding. I would like your team to submit a report to me detailing this new protocol for review. In this report be sure to include your opinions and conclusion for each accident report.

To aid you in this process my officers will provide you with a set of abridged incident reports that are characteristic of typical accident we regularly investigate. However, for legal reasons sections of the reports have been omitted and the names of those involved have been replaced. In each report you will find a general description of the accident followed by more detailed information pertaining to possibly relevant parameters in the accident. Additional information regarding friction coefficients and impact crush constants can be provided upon request.

I am confident that your team will exceed our expectations.

H. M. B. G. Kotakadeniya

Attachments: Case Files 06_015741
06_017742
06_014874
07-000863

Table 1. Typical Frictional Coefficients of Automobile Tires on Various Surfaces

gravel and dirt road	0.35
wet grassy field	0.20
dry asphalt	0.60
wet asphalt	0.45
snow-covered road	0.20-0.30
Ice	0.05-0.10
dry concrete	0.70
wet concrete	0.60
Steel on dry asphalt	0.14

Table 16.6 Small Cars Stiffness Coefficients

Vehicle	**Weight (lb)**	**Stiffness Coefficient (lb-ft/in)**
1979 Honda Civic	2180	4720
1979 Ford Fiesta	2190	4040
1979 Plymouth Champ	2310	4260
1979 Datsun 210	2430	3960
1979 VW Rabbit	2600	4860
1982 Toyota Corolla	2650	5340
1979 Chevette	2730	5150
Average	2441	4619
Range	+12/-11%	+16/-14%

Note: Data from *Fseld* Accidents. *Data Collection.* Analysts. *Methodologies and Crash Injury Reconstruction.* 1985. paper 850437, "Barrier Equivalent Velocity. Delta-V and CRASH3 Stiffness in Automobile Collisions" by Hight. Hight. and Lent-Koop. Figure 16.4.

Table 16.7 Medium Cars Stiffness Coefficients

Vehicle	Weight (Ib.)	Stiffness Coefficient (lb-ft/in)
1979 Mustang	3070	7610
1979 Mercury Capri	3070	7178
1979 Chevrolet *Monra*	3240	5970
1979 Volvo 242	3290	4600
1979 Ford Fairmont	3300	6000
1982 Volvo DL	3350	5040
1979 Volvo 244DL	3370	4960
Average	3241	5908
Range	+4/-5%	+28/-22%

Note: Data from *Field* Accidents. *Data Collection.* Analysts, *Methodoloies and Crash Injury Reconstruction.* 1985. paper 850437, "Barrier Equivalent Velocity. Delta-V and CRASH3 Stiffness in Automobile Collisions" by Height. Hight. and Lent-Koop. Figure 16.4.

Table 16.8 Full Sized Cars Stiffness Coefficients

Vehicle	Weight (lb)	Stiffness Coefficient (lb-ft/in)
1980 AMC Concord	3700	7460
1979 Plymouth Volare	3820	7170
1979 Old Cutlass	3820	5600
1979 BMW 528	3840	6400
1979 Ford Granada	3950	6145
1979 Mercury Marquis	4220	6300
1979 Ford LTD	4370	6850
1979 Dodge St. Regis	4460	6470
1979 Olds Regency	4710	7355
1979 Ford LTD II	4810	6000
1979 Lincoln Continental	5360	7384
Average	4278	6649
Range	+25/-14%	+12/-16%

Now Data (from *Field Accidents. Data Collection. Analysis. Methodologies and Crash Injury Reconstruction.* 1985. paper 850437. "Ramer Equivalent Velocity. Delta-V and CRASH3 Stiffness in Automobile Collisions by Hight. Hight. and Lent-Koop. Figure 16.4.

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
April 29, 2006	0422	3710	1120	06-015741

INTRODUCTION

This traffic collision occurred on Saturday April 29, 2006, at approximately 0422 hours. This traffic collision occurred on Pallamadu Rd, within the City of Colombo.

The collision involved a 1994 white Ford Explorer driven by [redacted], henceforth referred to as Driver A.

The Ford was traveling northbound on Pallamadu Rd in the number one lane of travel at an unknown speed when the driver somehow lost control of the vehicle. The truck rolled over onto its top side in the number 2 lane of travel and proceeded to skid 255 feet on the asphalt roadway.

Driver A received minor injuries to the arms and head by broken glass and was treated on the scene by emergency personnel.

Released Per
Public Records
Act Request

SCENE :

Section omitted.

Weather Condition

The following weather conditions were noted at Colombo Airport. The airport is located about ¼ mile from the scene.

Time	Temperature	Dew Point	Humidity	Pressure	Visibility	Wind	Conditions
0352	66.8° F	64.7° F	81%	29.95 in	8 miles	Calm	Clear
0452	66.2° F	64.3° F	83%	29.96 in	8 miles	Calm	Clear
0552	65.7° F	60.2° F	92%	29.95 in	8 miles	3.2 mph NNW	Clear

Traffic Control

The posted speed for the road in the area of this collision is 45 mph. The speed limit is clearly posted for both sides with Type R 45 MPH speed limit signs. The speed limit was established by a traffic engineering and speed survey.

MALT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	4/29/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
April 29, 2006	0422	3710	1120	06-015741

VEHICLES

Vehicle One (1994 Ford Ranger)

Description

Year:	1994
Make:	Ford
Model:	Explorer
License:	[redacted]
VIN:	[redacted]
Engine:	1.5L V4
Transmission:	5 speed Manual
Color:	White
Type:	2 door
Weight:	4580 pounds
Length:	174.5 inches (4673 mm)
Height:	67.5 inches (1714 mm)
Width:	70.2 inches (1778 mm)
Center of gravity:	24.1 inches (height)

Damage Description:

Front:

Minor to moderate damage was sustained to the front right portion of V1.

Right

Minor to moderate damage was sustained to this portion of V1. This damage consisted of scrapings where V1 was in contact with the road and broken side windows.

Left

I did not observed any damage to this portion of V1.

Rear

I did not observed any damage to this portion of V1.

Roof

Moderate damage was sustained to the roof of V1 but the average height of V1 remained unchanged.

MALT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	4/29/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 20, 2006	0518	3710	1120	06-017742

INTRODUCTION

This traffic collision occurred on Friday June 20, 2006, at approximately 0518 hours. This traffic collision occurred on Jawatte Rd, within the City of Colombo.

The collision involved a 1999 red Nissan Super Saloon driven by [redacted], and a 1994 black Ford Fiesta driven by [redacted].

The Nissan was traveling northbound on Jawatte Rd up a 7% grade. As the Nissan reached the top of the grade it collided head on with the Ford which was traveling southbound. The road north of the collision point, on which the Ford had been traveling, had a 0% grade. After impact, both vehicles slid together with locked wheels 5.8 meters down the hill.

Prior to the accident, about 3.2 kilometers south of the scene, an officer on patrol observed that the Nissan was traveling approximately 16 -24 km/h. The officer then left to respond to another incident on Kelaniya Rd.

Physical evidence at the scene indicated that the driver of the Ford was aware that he was about to impact Nissan. Wheel locked skid marks just prior to the collision were measured to be 9.4 meters in length and matched the tire pattern of the Ford. Roadway conditions at the time of the accident were slightly wet.

The driver of the Nissan was killed instantly. The driver of the Ford was transported via ambulance to Colombo Hospital received for treatment, then died later from his injuries.

SCENE :

Section omitted.

Weather Condition

The following weather conditions were noted at Colombo Airport. The airport is located about 3.2 km from the scene.

Time	Temperature	Dew Point	Humidity	Pressure	Visibility	Wind	Conditions
0452	19.3° C	18.2° C	81%	760.7 mm H_20	12.9 km	Calm	Light Rain
0552	16.8° C	17.9° C	83%	761.0 mm H_20	12.9 km	Calm	Foggy
0652	18.7° C	15.7° C	92%	760.7 mm H_20	12.9 km	5.1 km/h NNW	Foggy

Traffic Control

The posted speed for the road in the area of this collision is 40 km/h. The speed limit is clearly posted for both sides with Type R 40 KM/H speed limit signs. The speed limit was established by a traffic engineering and speed survey.

MALT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/20/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 20, 2006	0518	3710	1120	06-017742

VEHICLES

Vehicle One (1999 Nissan Super Saloon)

Description

Year: 1999
Make: Nissan
Model: Super Saloon
License: [redacted]
VIN:
Engine: 2200cc V4
Transmission: 5 speed Manual
Color: Red
Type: 4 door
Weight: 1225 kg

Damage Description:

Front:

There was moderate to severe damage to this portion of V 1. There was crumpling and creasing to the hood and sub-frame, along with breaks to the plastic front grill. Both headlights were broken out. An examination of the broken bulbs showed oxidation and melting to the filament. This indicated that the headlights were in the "On" position at the time of this collision. Some of the engine fluids (oil, coolant, brake fluid, etc.) had spilled onto the roadway at the collision scene.

Right

V1 sustained no visible damage to this end.

Left

V1 sustained no visible damage to this end.

Rear

V1 sustained no visible damage to this end.

Roof

V1 sustained no visible damage to this end.

MALT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/20/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 20, 2006	0518	3710	1120	06-017742

VEHICLES (Continued)

Vehicle Two (1994 Ford Fiesta)

Description

Year: 1994
Make: Ford
Model: Fiesta
License: [redacted]
VIN:
Engine: 1300cc V4
Transmission: 4 speed Manual
Color: Black
Type: 2 door
Weight: 1238 kg

Damage Description:

Front:

V2 sustained major damage to the entire front side from of the impact with V1. The center of the grill/bumper area was completely crushed and destroyed. No evidence of oxidation or melting of the headlight filaments could be found. This indicates that the headlights of V2 were in the "Off" position at the time of impact.

Right

V1 sustained no visible damage to this end.

Left

V1 sustained no visible damage to this end.

Rear

V1 sustained no visible damage to this end.

Roof

V1 sustained no visible damage to this end.

MALT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/20/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

II

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 24, 2006	0445	3710	1120	06-014874

INTRODUCTION

This traffic collision occurred on Saturday June 24, 2006, at approximately 0445 hours. This collision occurred within the intersection of Route A4 and Benet Rd, within the incorporated City of Colombo.

This collision involved a 2006 Acura TSX (V1) and a 2004 Ford Sterling Cement Truck (V2). The Acura was driven by [redacted], henceforth referred to as Person 1. The Ford was driven by [redacted], henceforth referred to as Person 2. The passenger in the Acura, seated in the front right seat, was [redacted].

The Acura was traveling eastbound on Route A4, in the number two lane of travel. The Ford had just entered the intersection, from the left turn lane, northbound Benet Rd to westbound Route A4. At impact, the Ford was in second gear. Maximum speed for a vehicle of this size, in second gear is 7-10 mph. This data can be supported by several case studies from the American National Highway Traffic Safety Administration and other related studies involving vehicles of this size.

The force of the impact between the Acura and the Ford, forced the Ford to be moved from an angle of a left turn to positioning straight forward. The Acura was moved from traveling eastbound to facing southbound. All parties involved in this collision received injuries and were either treated on scene or transported to local hospitals. The passenger in the Acura died from his injuries at 2000 hours on June 24, 2006.

PHYSICAL EVIDENCE

I documented the scene, walking from east to west. On the south side of Route A4 in the number two lane of eastbound traffic, I noticed skid from V1. This skid was measured by a roll meter with a distance of 67 feet. An additional 20 feet of skid was within the intersection, caused by the two vehicles sliding together. This evidence leads me to believe that P1 noticed V2 turning in the intersection and applied his brakes in a "Panic" situation.

At the collision scene, there was evidence of V 1 and V2's impact within the intersection. V1 was still impacted with the front left tire of V2. There was a mixture of engine fluids, vehicle parts, and glass. Using marking paint, I painted both V1 and V2 in their original positions before they were moved by tow trucks.

An interior inspection of V2 showed that it was "locked" in second gear and even when depressing the clutch, I could not remove the vehicle out of second gear. The tow driver had to manually unlock the transmission to move V2.

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/24/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

11

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 24, 2006	0445	3710	1120	06-014874

SCENE:

Section Omitted

Weather Conditions

The following weather conditions were noted at the Colombo Airport. The airport is about 1/4 mile north of the collision scene.

Time	Temperature	Dew Point	Humidity	Pressure	Visibility	Wind	Conditions
4:52 AM	64.9° F/18.3° C	61.0° F/16.1° C	87%	29.95 in/ 1014.1 hPa	4.0 miles/ 6.4 km	3.5 mph/ 5.6 km/h WWS	Overcast
5:52 AM	64.9° F/18.3° C	61.0° F/16.1° C	87%	30.00 in/ 1015.8 hPa	4.0 miles/ 6.4 km	8.1 mph/ 13.0 km/h SSE	Overcast
6:44 AM	66.2° F/19.0° C	62.6° F/17.0° C	88%	30.01in/ 1016.1 hPa	3.0 miles/ 4.8 km	3.5 mph/ 5.6 km/h North	Overcast

Traffic Control

The intersection of Route A4 and Benet Rd is controlled by a four way electrical signal system. During this investigation, I observed the signal phase from all four directions and found them to be working properly. The posted speed limit for Route A4 is 55 mph. The speed limit is clearly posted for both east and westbound traffic with Type R 55 MPH speed limit signs. The speed limit was established by a traffic and engineering survey.

VEHICLES

Vehicle One (V1, 2006 Acura TSX)

Description

Year: 2006
Make: Acura
Model: TSX
License: [redacted]
VIN: [redacted]
Engine: 2.4 L 205 hp 14
Transmission: 5 speed Automatic
Color: Blue
Type: 2 Door
Weight: 3256.2 pounds

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/24/06		

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 24, 2006	0445	3710	1120	06-014874

VEHICLES (Continued)

Damage:

Front:

The damage sustained to this portion of V 1 consisted of the entire front bumper being removed from the vehicle. The right side headlight assembly was completely broken out. An inspection of the broken headlight assembly, with the exposed headlight bulb filament, showed signs of oxidation and melting of the filament. This evidence showed that P1 had the headlights of V1 in the "On" position. The hood and right quarter panel was crumpled and dented. V1 had also expelled some of its engine fluids, i.e. Radiator fluid, oil, brake fluid.

Right:

The only damage sustained on this side of V 1 was the front right quarter panel. This damage consisted of the quarter panel being dented and crushed.

Left:

Besides slight crumpling and warping to the front left quarter panel, no other damage was sustained to this side of V1.

Rear:

I did not observe any damage to this portion of V1.

Roof:

I did not observe any damage to this portion of V1.

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/24/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

15/30

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
June 24, 2006	0445	3710	1120	06-014874

VEHICLES (Continued)

Vehicle 2 (V2, 2004 Ford Sterling)

Description:

Year: 2004
Make: Ford
Model: Sterling
License: [redacted]
VIN: [redacted]
Engine: Mercedes MBE 4000 450
Transmission: 8LL
Color: White
Vehicle Type: 3 Axle Short Pour Cement Mixer
Weight: 18600 pounds

Damage:

Front:
No visible damage had occurred to this side.

Left:
Besides the front left wheel assembly being broken, with several air and fluid lines broken, no other visible damage occurred to this side.

Right:
No visible damage had occurred to this side.

Rear:
No visible damage had occurred to this side.

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	6/24/06		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

11

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
Jan 11, 2006	1057	3710	1120	07-000863

INTRODUCTION

On Thursday, January 11, 2007 at approximately 1057 hours, a traffic collision occurred within the intersection of Tikali Dr. and Vihara Rd. A 1995 Volkswagen Jetta, which was traveling westbound on Tikali Dr, struck a 1992 Saturn SL-1 broadside, which was traveling southbound on Vihara Road.

The 1992 Saturn SL-1 (V1) was driven by [redacted], henceforth referred to as Person 1, who sustained major injuries in this collision and was transported, via ambulance, to Colombo Trauma Center. P1 died at 2030 hours, due to his injuries.

The 1995 Volkswagen Jetta (V2) was driven by [redacted], henceforth referred to as Person 2, who sustained minor injuries in this collision and was transported, via ambulance, to Kelaniya Medical Center for treatment. P2 was later released from the hospital.

Based on the statement of P2 and three independent witnesses, P1 had run the red light for southbound Vihara Rd. P2 had a green light for westbound Tikali Dr. Evidence at the scene showed that P1 may have been aware that P2's vehicle was about to impact with him. There were front wheel locked skid marks, just prior to the collision. The force of the collision caused the two vehicles to skid together to rest.

PHYSICAL EVIDENCE

At the Area of Impact, I observed locked wheel skid from the front tires of V1 prior to the area of impact. This wheel skid was measured to be 10 feet. The skid marks post-collision measured to be 35 feet in the southwest direction [220° Azimuth].

Roadway Description

Section Omitted

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	1/11/07		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

II

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
Jan 11, 2006	1057	3710	1120	07-000863

Weather Conditions

The following weather conditions were noted at the Colombo Airport.

Time	Temperature	Dew Point	Humidity	Pressure	Visibility	Wind	Conditions
10:29 AM	60.8° F/16.0° C	48.2° F/9.0° C	63%	29.96 in/ 1014.4 hPa	9.0 miles/ 14.5 km	8.1 mph/ 13.0 km/h South	Overcast
10:52 AM	61.0° F/16.1° C	48.0° F/8.9° C	62%	29.96 in/ 1014.4 hPa	9.0 miles/ 14.5 km	9.2 mph/ 14.8 km/h South	Overcast
11:42 AM	60.8° F/16.0° C	46.4° F/8.0° C	59%	29.93 in/ 1013.4 hPa	10.0 miles/ 16.1 km	9.2 mph/ 14.8 km/h South	Overcast

VEHICLES

Vehicle One (VI, 1992 Saturn SL-1)

Year: 1992
Make: Saturn
Model: SL-1
Color: Brown
License: [redacted]
VIN: [redacted]
Engine: 1.9L 85 hp 14
Transmission: 4 speed automatic
Weight: 2313 pounds

Damage Description:

Front:
V1 sustained no visible damage to this end.

Left:
The majority of the damage sustained by V1 occurred on this side. At the deepest intrusion, the crush measured 36". The entire left side from the driver's side door to the passenger side door was crushed. There was minor to moderate crushing to the front and rear quarter panels.

Right:
Besides the removing of the passenger front and rear doors by SLFD with the Jaws of Life, no visible collision damage was observed on this side.

VEHICLES (Continued)

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	1/11/07		

SRI LANKA POLICE DEPARTMENT MAJOR ACCIDENT INVESTIGATION TEAM

DATE OF INCIDENT	TIME	NCIC NUMBER	OFFICER I.D.	NUMBER
Jan 11, 2006	1057	3710	1120	07-000883

Damage (Continued)

Rear:
V1 sustained no visible damage to this end.

Vehicle Two (V2,1995 Volkswagen Jetta III Celebration Edition)

Year: 1995
Make: Volkswagen
Model: Jetta III Celebration Edition
Color: Black
License: [redacted]
VIN: [redacted]
Engine: 2.0 L 115 hp I4
Transmission: 5 Speed manual
Weight: 2648 pounds

Damage Description:

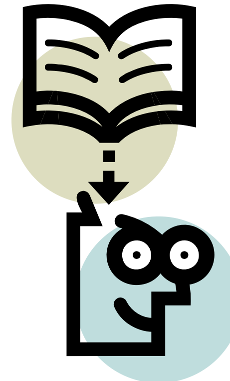
Front:
The majority of the damage sustained by V2 was isolated to this side. There was moderate crushing to the front bumper and hood. The length of crush to the front end was 6" at its deepest point. The both headlight and lighting assemblies were broken and knocked out.

Left:
Besides minor crush and dents to the front portion of the front quarter panel, no other visible damage was observed to this side.

Right:
Besides minor crush and dents to the front portion of the front quarter panel, no other visible damage was observed to this side.

Rear:
V2 sustained no visible damage to this end.

MAIT PREPARER'S NAME	I.D. NUMBER	DATE	REVIEWER'S NAME	DATE
A. Ahubudu	1120	1/11/07		



Appendix B: Multimedia Example MEA

MEMORANDUM

To: Dynamics R Us Educational Consultants

From: Smith Publishing Inc.

Date: 10.27.08

Subject: Multimedia Based Student Learning Tools

We are pleased to announce the completion of our new website for college level engineering students. In order to expand our current educational product offerings beyond textbooks, we are currently offering additional educational information on the web. Our website is intended to provide additional aid outside of the classroom to help students understand fundamental engineering concepts.

Currently, our website offers a wide selection of example problems to supplement statics, dynamics, thermodynamics and heat transfer textbooks. We are pleased with the responses that we have been receiving regarding this new site, but we want to do more. Here at Smith Publishing we have a passion for education and understand that all students have different learning styles. To expand our audience and to help more students in their quest for knowledge we will be dedicating a portion of our site to multimedia learning.

We plan to hire university professors who have taught with our textbooks to create some of these multimedia tools. In order to provide consistency to their submissions, we need to provide guidelines to them. Due to your extensive experience in student education, we would like you to create these guidelines for us.

It would be extremely helpful if you could outline what you think are the most important characteristics to make a good multimedia example problem. Please follow this with specific guidelines that we can provide to the professors who will create the examples for us. We would also like you to create one example problem that we can send to potential contributors.

Thank you for your time and we look forward viewing your guidelines and multimedia example problems.

John B. Noble

John B. Noble
Chief Executive Officer
Smith Publishing Inc.

Appendix C: Catapult MEA

PETERBOROUGH CITY COUNCIL

MEMORANDUM

To:

From: Peterborough City Council for Peterborough Museum Art Gallery

Date: 11.17.08

Subject: Catapult design for upcoming Medieval Machines Exhibition

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Due to the overwhelming success of our most recent interactive Medieval Machines exhibition, we are pleased to announce plans for a similar exhibition this upcoming year. We will use many of our existing medieval displays and activities but are also looking to expand the exhibition this time around and will need the help of your engineering design firm in developing our newest featured display.

This year, the featured display will be a full size medieval catapult replica which will be used in a series of demonstrations. In order to develop successful demonstrations for the catapult display, we need you to provide us with a selection of different launch settings. A launch setting is defined by launch angle, pin location and catapult base height. The settings you provide us with will allow the users to hit specifically placed targets. Along with the specific launch settings, we also need some sort of algorithm or instruction set from your engineers which explains how to find a launch setting for a given distance between the catapult and target. With your instruction our employees using the catapult should be able to make any necessary changes if any issues or complications may arise on launch day.

To aid your progress we will be providing you with a scale model of the catapult here at are museum in Peterborough, England. All dimensions and material stiffness are accurately scaled which should provide you with all of the necessary information and will allow you to test your findings and prove your results. Accuracy in this demonstration is critical for both the safety of our museum guests and employees as well as for a successful demonstration.

For further information on our museum and our medieval programs please view our past articles at the links below. Thank you for your time and we look forward reviewing your results.

John Smith

Peterborough Museum Art Gallery Program Director