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Clutch Pedal Acceleration

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Abstract: ***The design modification proposed is that of integrating acceleration and clutch mechanism under a single pedal control. By this modification the major out turn is that the vehicle accelerates as and when the Clutch Acceleration Pedal is released, instead of acceleration by pedal pressing as in the case of conventional cars. In this design the clutch mechanism is operated when the Clutch Acceleration pedal pressed to the maximum. At the end of pedal by having mechanical linkage, acceleration mechanism is neutralized and a further force extends the rod which operates the clutch. This way we bring two mechanisms under a single pedal.***

Keywords: clutch-pedal acceleration, design modification, integrating mechanism

1.Introduction

- **Sudden unintended acceleration** (**SUA**)[1] is the unintended, unexpected, uncontrolled acceleration of a vehicle, often accompanied by an apparent loss of braking effectiveness. Such problems are caused by driver pedal misapplication.
- Unintended acceleration resulting from pedal misapplication is a driver error wherein the driver presses the accelerator when braking is intended. Some shorter drivers' feet may not be long enough to touch the floor and pedals, making them more likely to press the wrong pedal due to a lack of proper spatial or tactile reference.Pedal misapplication may be related to pedal design and placement, as in cases where the brake and accelerator are too close to one another or the accelerator pedal too large.
- In Japan, around **7,000 accidents** are caused annually by pedal misapplication between the brake pedal and the accelerator pedal.
- These accidents occur when drivers may mistake the brake for the accelerator or press down on the accelerator too strongly, resulting in collisions with nearby vehicles, walls or pedestrians. Drivers **aged 16 to 20** and **those 76 or older** were most likely to be involved in pedal misapplication crashes.
- At panic situation i.e. when you have very less time for reacting to a sudden unwanted situation while driving a car, it is natural to step on acceleration pedal instead of brake pedal
- Then the car runs out of control and leads to accidents
- Hence to overcome this problem we have proposed a design modification in which both the accelerator and clutch are brought under a same pedal,no matter which pedal you press the car will not accelerate and provide you extra time to react better

2.Characteristics of Pedal Misapplication Crashes[1][2]

Schmidt, Young, Ayres, and Wong (NHTSA Report) used keywords to search police narratives contained in the North Carolina crash database for pedal error crashes that occurred from 1979 to 1980. They identified 219 crashes for analysis, including pedal application errors and foot slips, where the drivers stated that their foot contacted the accelerator rather than the brake. All these crashes occurred after the driving cycle had begun rather than at the beginning of a driving cycle when a driver shifted from “Park” to “Reverse” or “Drive.” The authors indicate this may be the result of brake transmission shift interlocks installed on vehicles to prevent this type of pedal misapplication.

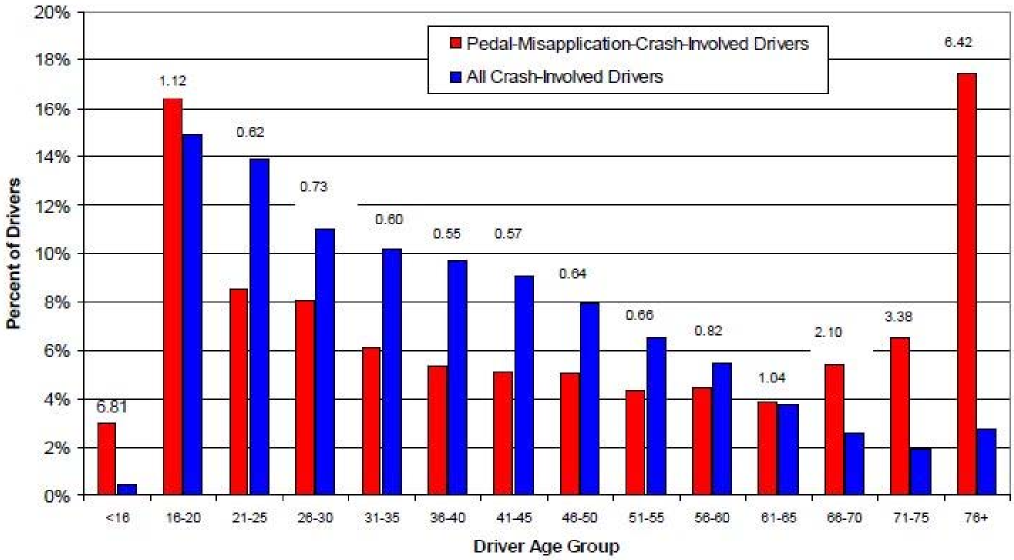
The study classified crashes as occurring either during parking or driving on the road. Of the 219 crashes, only 23 (10.5%) occurred during a parking maneuver. Of these, 14 (61%) occurred while the driver was moving forward, and 9 (39%) when the driver was moving in reverse. Of these 23 parking lot pedal misapplication crashes, 8 occurred because the driver’s foot slipped from the brake to the accelerator (none because the foot was slippery or wet) and 15 occurred because the driver hit the wrong pedal. Parking lot crashes were further classified according to whether the scenario was hurried or unhurried based on temporal urgency, as stated in the crash narratives. Of the 19 crashes that could be classified based on the information in the police report, 18 (95%) were unhurried – the driver was not responding to an urgent event.

The majority of the pedal error crashes occurred during driving (196 of 219, or 89%). Of these, 111 (57%) were caused by a foot slip, and 85 (43%) because the driver pressed the wrong pedal. Of the 171 crashes where the scenario could be classified, 117 were unhurried (68%) compared to 54 hurried (32%). The driving circumstances surrounding the pedal error crashes could be classified in 154 of the crashes that occurred during driving (includes slips and wrong pedal instances) as follows: slowing normally (36%); turning (22%); the vehicle was stopped (18%); the driver was distracted (10%); the vehicle was hit by another object (8%); the driver was avoiding an obstacle (6%). In nearly all the crashes that occurred because a driver was avoiding another object or the vehicle was stopped, the cause of the pedal error was a foot slip. In crashes that occurred when the driver was slowing, 76% occurred because of a foot slip and 24% occurred because the driver hit the wrong pedal. All the crashes that occurred when a driver was hit by another object occurred because the driver hit the wrong pedal. In the crashes that occurred during a turning maneuver, the majority (82%) occurred because the driver hit the wrong pedal and 18% were caused by a foot slip.

These findings highlight the fact that pedal application errors may occur more often during the driving cycle than at initial start up, as earlier believed, and may commonly occur under unhurried conditions. Although brake-shift interlocks appear to have been successful in preventing pedal misapplication crashes at the beginning of a driving cycle, they cannot prevent a pedal misapplication crash when the error occurs during the driving cycle. Schmidt et al. (1997) found that pedal errors involving a driver hitting the wrong pedal most often occurred during turning maneuvers and when a driver was presumably startled after hitting (or being hit by) another object.

2.1 Driver Age

Driver age was available for only 683 of the 899 pedal misapplication crashes identified in the news media and 2,399 of the 2,411 crashes identified in the North Carolina State crash database. Due to the small number of crashes identified in the NMVCCS database, NMVCCS findings by age are not included in this discussion. Although the media analysis and the North Carolina crash analysis both show higher crash involvement at both ends of the age distribution, the media analysis showed smaller proportions of younger drivers and larger proportions of older drivers than the North Carolina crash analysis.



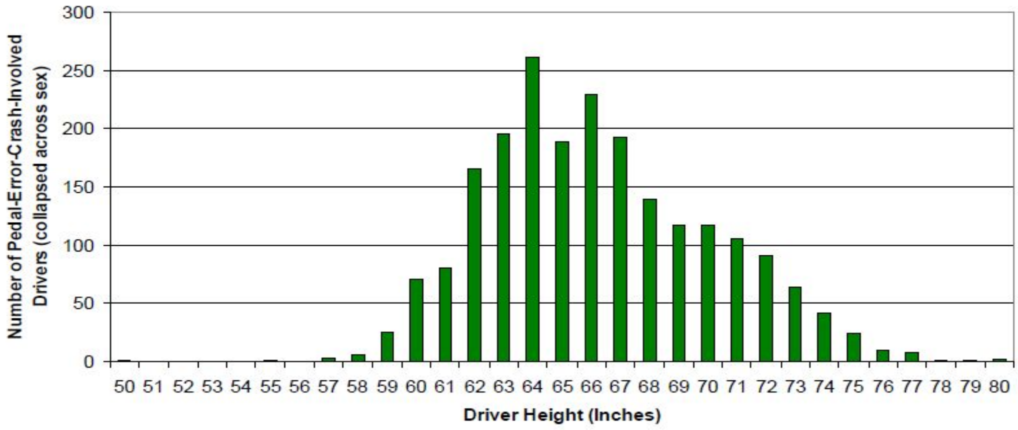
2.2 Driver Sex

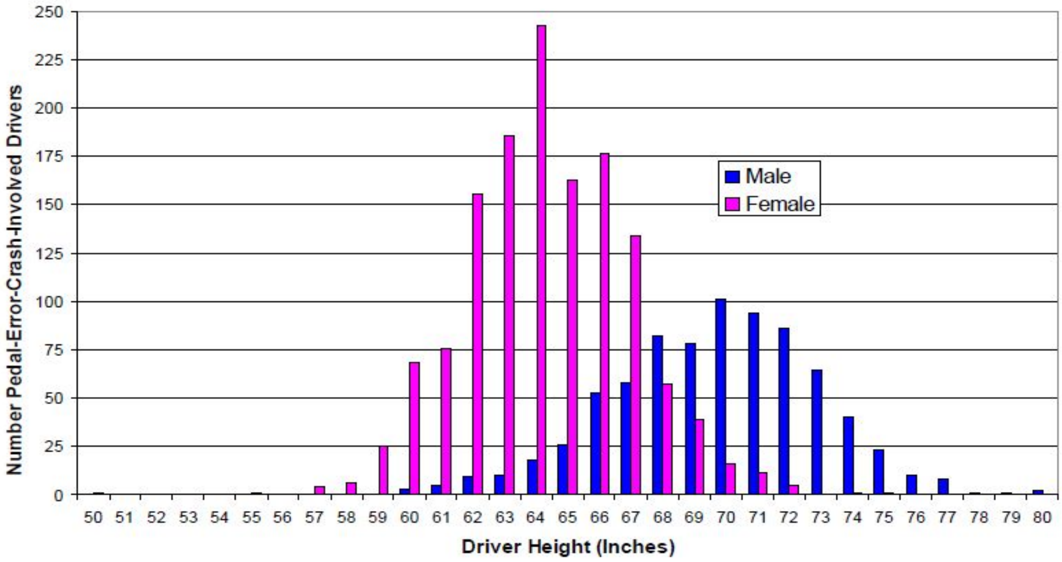
Driver sex was not reported in the North Carolina data for 11 of the 2,411 drivers who made pedal application errors. For the remaining 2,400 crashes, males accounted for 37% and females 63%. Table 4 shows that within each of five broad age groups, larger proportions of females than males were involved in pedal misapplication crashes. Statewide crash data for *all* crashes by driver sex for the years 2004 – 2008 show that males accounted for 56% of crashes and females 44%. Thus, female drivers appear to be overrepresented in crashes involving pedal application errors, compared to their representation in *all* crashes.

Driver Age Group	Driver Sex	
	Male	Female
<21	39%	61%
21-35	41%	59%
36-55	32%	68%
56-75	35%	65%
76+	37%	63%

2.3 Driver Height

Data describing driver sex in pedal misapplication crashes may be confounded by driver height, as females are generally shorter than males. Certified Driver Rehabilitation Specialists (CDRSs) who participated in the panel meeting in this project stated that because women are smaller than men, their “carfit” in the driver’s seat is often worse. Accordingly, we conducted analyses of the heights of drivers involved in pedal misapplication crashes using data extracted from the North Carolina license database. Driver height was available for 772 males and 1,369 females.





3.Startle or Panic Responses

We read each crash narrative and news article and coded situations where startle or panic was stated or inferred, based on what we learned in earlier project tasks about the contribution of a startling stimulus to a pedal misapplication. The frequency of startle reactions in the analysis sets may be underrepresented due to the lack of detail in many of the crash narratives. The situations we coded in the North Carolina crash database sample included:

- Startle following an initial collision (e.g., the driver reacts to a crash by hitting the wrong pedal).
- Startle following loss of control of the vehicle (e.g., the driver panics when the vehicle skids or drifts out of the lane, and during the recovery the driver hits the gas instead of the brake).
- Panic stop to avoid a collision (e.g., an animal, vehicle, or pedestrian is in the driver's immediate path, and the driver tries to slam on the brakes to avoid a collision).
- Startle following a driver's foot slipping from the brake to the accelerator (e.g., the driver panics after the foot slips off the brake, and while trying to re-contact the brake, hits the accelerator).

4.Injuries and Fatalities

Crash reporting law enforcement officers in North Carolina use the following definitions to categorize injury severity.

- **Killed** – Deaths, which occur within 12 months after the crash
- **Disabling injury (Type A)** - Injury obviously serious enough to prevent the person injured from performing normal activities for at least one day beyond the day of the collision. Examples include massive loss of blood, broken bone, and unconsciousness of more than momentary duration.
- **Evident injury (Type B)** - Obvious injury, other than killed or disabling, which is evident at the scene. Bruises, swelling, limping, soreness, are examples. Class B injury would not necessarily prevent the person from carrying on normal activities.
- **Possible injury (Type C)** - No visible injury, but person complains of pain, or has been momentarily unconscious
- **No injury**
- **Unknown**

The 2,411 pedal misapplication crashes in the North Carolina crash analysis set involved a total of 5,623 road users. This included the 2,411 drivers who made the pedal application errors and the 892 passengers they were transporting, as well as 2,271 occupants of the other vehicles involved in these pedal misapplication crashes, and 49 pedestrians. Injury status was missing for 841 "other road users" (including 3 pedestrians) and 46 "pedal-application-error-vehicle" occupants. Table 14 presents the injury status for the 4,736 road users involved in these crashes, by road user type (pedal misapplication vehicle occupant, other vehicle occupant, pedestrian), where the injury status was known.

The majority of road users involved in North Carolina pedal misapplication crashes (82%, across all road user types) sustained no injuries. Next in prevalence were road users with possible injuries (14%) and evident injuries (4%). Ten road users sustained disabling injuries (less than 1% of the sample), and 1 road user was fatally injured (also less than 1% of the sample). Of importance to this discussion, only 7% of pedestrians involved in pedal misapplication crashes were *not* injured. Although none of the pedestrians was killed, 7% received disabling injuries, 46% evident injuries, and 41% possible injuries.

Injury Status	Road User Type						All	
	Pedal Misapplication Vehicle		Other Vehicles		Pedestrians			
	N	%	N	%	N	%	N	%
Fatal injury (K)	1	0.03%	0	0.00%	0	0.00%	1	0.02%
Disabling injury (A)	5	0.15%	2	0.14%	3	6.52%	10	0.21%
Evident injury (B)	132	4.05%	33	2.30%	21	45.65%	186	3.93%
Possible injury (C)	347	10.65%	302	21.07%	19	41.30%	668	14.10%
No injury (O)	2,772	85.11%	1,096	76.48%	3	6.52%	3,871	81.74%
Total	3,257	100.00%	1433	100.00%	46	100.00%	4736	100.00%

5.Pedal Misapplication Location

5.1 Parking Lots

DRSs training clients to use adaptive equipment provided additional insight about the location of pedal misapplications, as evidenced by the following comment:

"Any of us who've trained people on adaptive equipment know that before I let somebody go with a left-foot accelerator or hand controls, I am spending so much time in parking lots, because if there's going to be an error between gas and brake with any of that adaptive equipment, it's going to happen in a parking lot. That's where the majority of my time is spent at the end of my training with adaptive equipment. I've got to see 20 good parks and back-ups in different congested parking lots, going in and out before I'm ever going to let that person go. That's where it's going to happen; it's going to happen right there in a parking lot."

Similarly, several DRSs said that their final on-road test to ensure that the driver is safe, is the local discount store parking lot, because everyone's lot is "equally crazy" and if a driver is going to exhibit a problem that has not shown up in the lower-level, open-road portion of a test, the parking lot is where it is going to occur.

Twelve of the 14 DRSs who conduct on-road assessments with clients indicated that the majority of the pedal application errors they observed occurred in parking lots. The drivers being evaluated became nervous or anxious when they got close to other cars and there was little room to maneuver. Many foot movements are required in parking lots. Tasks (planning processes and foot movements) are compressed, so the demand for divided attention skills is increased. People need to look over their shoulders more frequently in parking lots and that puts them "out of position" which can lead to pedal application errors.

5.2 On-Road

Only 2 of the 14 DRSs who conduct on-road assessments and training indicated that most of the pedal misapplications they had observed were on-road (as opposed to in parking lots). Examples were: during a right turn after stopping at a stop sign; in stop-and-go traffic; on the highway; and in cognitively taxing situations that require good divided attention skills. These included neighborhood streets with people and cars on the roadsides, and on a 40-mph roadway where the driver had to respond quickly to traffic signal changes. Other on-road situations where pedal application errors occurred included complicated maneuvers that require the driver to change directions, such as 3-point turns.

One of these DRSs may have a more fit clientele than the others (i.e., more typical of the general population); included among her clients were research participants who were not medical referrals for driving evaluations. This DRS indicated that 75% of the pedal application errors she had observed occurred on-road (and not in parking lots). The other DRS indicated that on-road pedal application errors were most likely to occur when her clients were startled.

5.3 During the Final 30 Seconds of a Trip

Panelists noted that pedal application errors were more likely to occur during the final 30 seconds of a driving evaluation. Either something distracted clients at the end of their drives, or they were relieved that the evaluation was over and did not feel the need to concentrate.

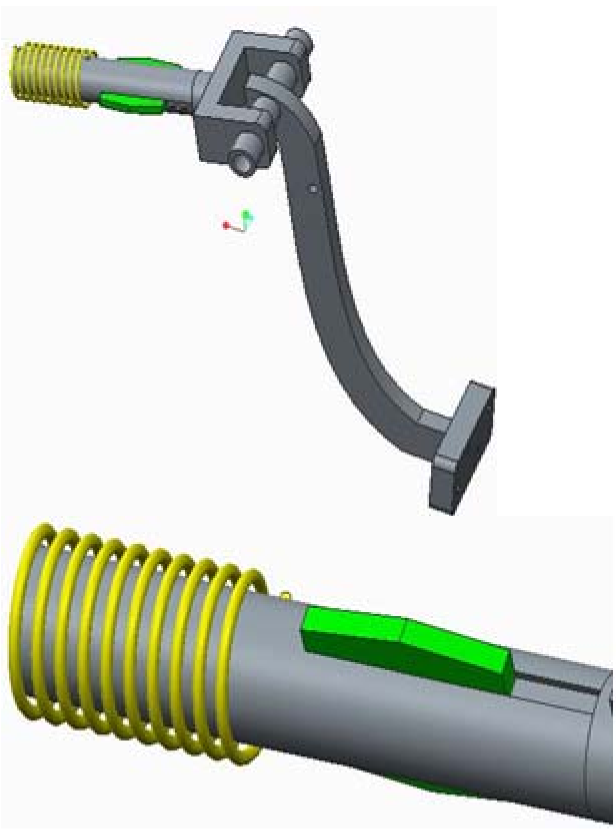
When asked whether this might be a consequence of fatigue, the DRSs said, no, it was more of a "let down" response;

drivers just did not concentrate as hard at the end because the evaluation was "over." Another DRS said she has observed 10 to 15% of her clients run the stop sign at the end of their evaluation. These clients performed well on the whole evaluation, until they got to the end. It is the same phenomenon as when pedal application errors occur in the driveway and the garage, where drivers hit their houses. They "relax" from the driving task when they reach home, or at the end of their trip, and that is when a pedal misapplication occurs.

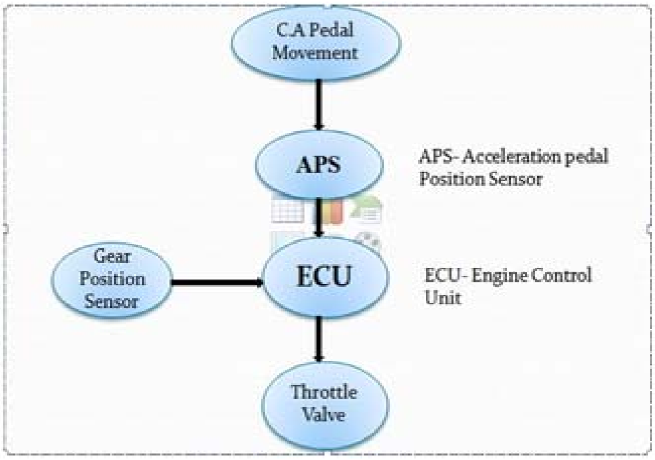
Crash Location	Age Group					
	N	20 or younger	21-35	36-55	56-75	76+
Commercial Parking Lot	416	44 (50%)	33 (47%)	37 (47%)	116 (69%)	186 (74%)
Residential Parking Lot	35	7 (8%)	9 (13%)	4 (5%)	8 (5%)	7 (3%)
Driveway	49	9 (10%)	5 (7%)	7 (9%)	8 (5%)	20 (8%)
On-Road (not intersection)	107	18 (20%)	20 (29%)	19 (24%)	24 (14%)	26 (10%)
Intersection	45	10 (11%)	3 (4%)	10 (13%)	10 (6%)	12 (5%)
Parking Garage	4	0 --	0 --	1 (1%)	1 (1%)	2 (1%)
Total	656	88	70	78	167	253

* Percentages of drivers in each age category (column percents)

5.4 3D Model



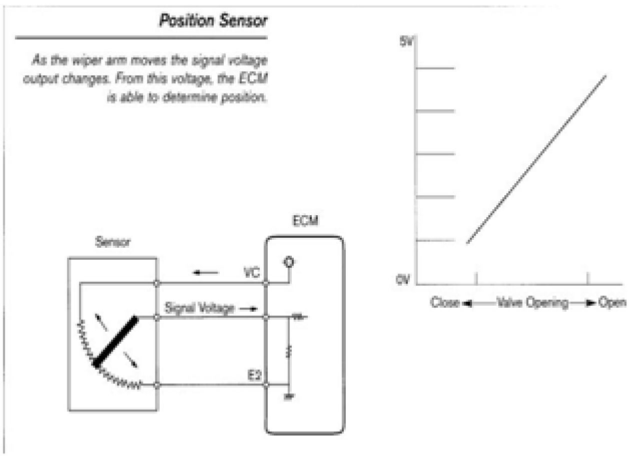
5.5 Functional Flowchart:[4]



6.Working

6.1 Accelerating Mechanism:[3]

- When the C.A. pedal is depressed the Accelerator Pedal Positioning Sensor (APS) senses the amount of deflection and generates a corresponding voltage.
- This voltage is send as an input signal to the Engine Control Unit (ECU).
- Like in conventional cars the ECU reads the voltage and gives corresponding command signal to the throttle valve control mechanism.
- So when the pedal is depressed the throttle valve decreases in its angle and hence it blocks the path of the inlet manifold.
- As and when the pedal is released throttle valve opens up and more of air-fuel enters the combustion chamber and we obtain acceleration.



6.2 ECU Modification

- One complete depression of C.A. pedal gives the complete speed range of the current gear the vehicle is running on. E.g. If the car is at 3rd gear, then the fully depressed position of pedal will give a speed of 30kmph and fully retracted position of the pedal gives 50kmph.
- Hence the ECU obtains the current condition of the gear and operates the throttle valve accordingly.

6.3 Clutching Mechanism

- The clutch mechanism is obtained at the fully depressed condition of the C.A. pedal.
- At this position a small linkage from the pedal opens a lock. Now when lock opens the pedal is jammed and hence it is not allowed to retract back.
- The lock is nothing but a small arrangement made to stop the movement of clutch rod.
- Now with the lock opened, force applied to the pedal moves the clutch rod in a linear direction.
- This movement is used in operating the clutch.
- When the clutch is to be released, force on the pedal is gradually decreased and by fulcrum action the clutch rod retracts automatically.
- When the clutch rod is fully retracted it hits a linkage mechanism which closes the lock and opens up the C.A. pedal.

7.Market Overview

- The targeted market is the Automobile Sector which is the leading sector in any part of the world.
- Hence we have a very large scope wherein the automobile sector would want to employ this design modification for the many advantage which our mechanism possesses.
- The Indian automotive industry has already attained a turnover of **Rs. 1,65,000 crore (34 billion USD)** and has provided direct and indirect employment to 1.31 crore people in the country.

8.Cost Analysis

As it is a modification design we can either modify it on conventional cars or start it at the factory level. Modification of existing cars can prove very costly and complicated since the ECU is already pre-programmed with normal actions. Change of these setup will be very complicated and time consuming. Hence the suggestion would be to manufacture new set of vehicles with all these design modifications.

<u>For modification:</u>
Pedal : Rs. 2,000
APS : Rs. 9,500
ECU : Rs. 12,000
Gear position sensor : Rs. 3,000
Manufacturing and assembly: Rs. 2,500
Total : Rs. 29,000

9.Future Plans and Benefits

- By further research and modification this new design should be bought into reality.
- Modification to be found to eliminate the clutch and accelerator ratio so as to drive with ease in hilly regions.
- If we are able to reduce accidents by a distinctive amount through our technology, then in near future we will see all the cars utilizing our design, which will be nothing short of a revolution.

Advantages:
- Specific kind of accidents can be reduced
- No matter which pedal the driver presses in panic, the vehicle will slow down

Disadvantage:
- Driver may find it difficult to adapt to a new mechanism
- Foot cannot be taken off the pedal while the car is in motion

10. Conclusion

Hence the idea of design modification of clutch and accelerator assembly can greatly reduce the amount of accidents that happen out of panic. If employed correctly then proper gear-speed relationship can be obtained which will increase the fuel efficiency.

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