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Paper #XXXXXX

A Lesson from the past For Safer Future Tactical Vehicles

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ABSTRACT

Vehicle occupant safety is or at least should be the highest priority because of many lives, property and productivity lost every year to accidents. However in reality if there is no strong advocacy to watch and take action (commercial world) or due to mission requirements and special circumstances such as military operations, often safety falls by the way side. Accidents are generally caused because of the operator's inability to anticipate, see and plan for events during operation of the vehicle and/or by the physical surrounding he or she has to perform in.

The vehicle is a tool designed to perform functions necessary to safely take the occupants from one point to the other. A badly designed tool or an operator lacking experience in the use of the tool or both increase the possibility of an accident occurring.

Tactical vehicles have specialized mission profiles and often need to meet ever increasing demands for performance and utility. These vehicles are often modified by the users to meet their specialized mission needs without attention to possible safety concerns the change might create.

The US Army, National Automotive Center (NAC), safety thrust is to constantly be aware of the safety implications of tactical vehicle operation and the latest technologies applicable to these vehicle platforms to transfer such technologies to the user to make available safer vehicle systems while maintaining optimum performance and utility.

INTRODUCTION

There are 3 basic variables that may be put in the form of an equation representing vehicle occupant safety:

- Operator
- Hardware (The vehicle)
- Mission

And the basic equation may be shown as:

$$\text{Safety} = \frac{\text{Mission} + \text{Hardware}}{\text{Operator}}$$

The operator is the common denominator since it tries to accomplish a mission using the hardware (vehicle). This paper examines tactical vehicle, operator,

mission and hardware interfaces for their interrelation and effect on safety of operation. It also attempts to demonstrate existence of a relationship between the mission requirements and mishaps or injuries.
I will also recommend possible solutions.
Tactical vehicles are customarily designed to stay in the fleet for 20 to 25 years. However, mission necessary, hardware used throughout their active lives and associated technologies evolve at a faster rate than the vehicle design. This potentially creates unsafe conditions for the operator/occupant when such hardware is carried or operated inside the vehicle.
There is very little leg room in most tactical vehicle cabs. It is almost as though it is an unwritten rule that the soldier has to be uncomfortable or may be the mere fact of being in combat necessitates degradation of comfort level. Granted military vehicles are all about functionality but that should not mean uncomfortable, cramped quarters with potential safety hazards in the from of too many hard, sharp corners closer than what is considered safe in a collision or roll-over.
The soldier is given a mission to accomplish and to do that he or she does what gets the job done such as modifications to accommodate additional equipment with little or no regard for their safety implications.
In tactical vehicles the mission dictates hardware deployment inside the vehicle cab. Often vehicle designers have no idea what hardware is going to be used inside the vehicle several years in the future. It is also very unclear how s equipment dimensions will change as technology advances.
Need for communication between the vehicle crew, the command, and the unit levels all at different frequencies using multiple transmitters as well as the need for other navigation and night vision equipment has led to potentially hazardous vehicle cab environment. In an accident there will be a much higher chance of sever injury due to the occupants coming in contact with these hard and sharp objects (equipment) even if they are belted in.

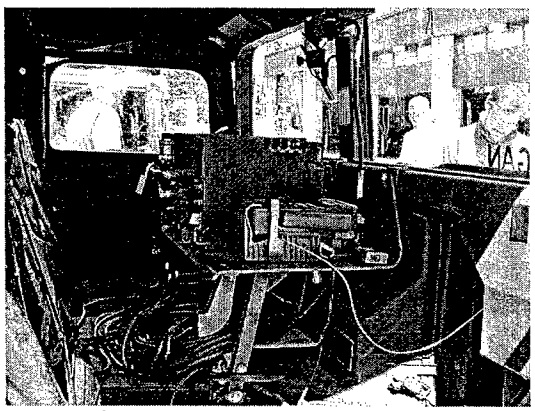
Fig 1. See tray edges (Ref. 3)

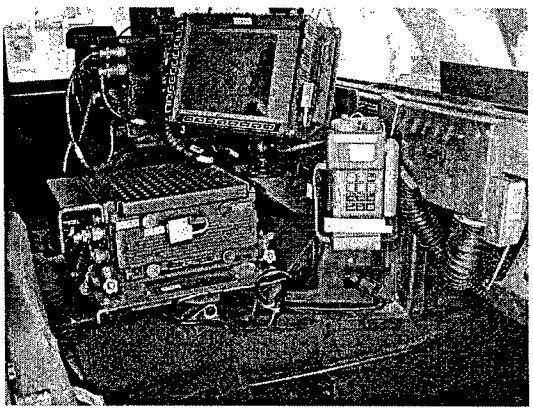
Fig 2. Notice how much communication and navigation hardware is packed inside the cab (Ref. 3)

Fig 3. Notice how little room there is (Ref. 3)

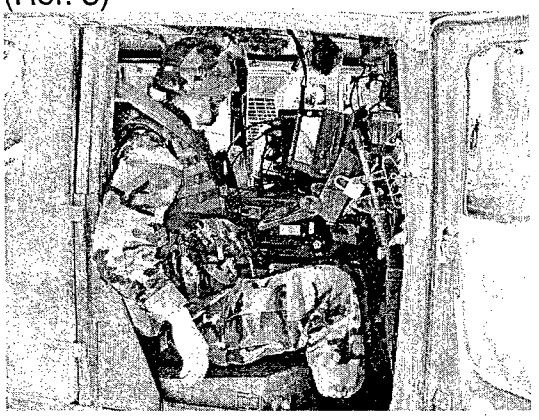

Fig 4. Notice the location of the keyboard relative to the soldier's chest (Ref. 3)

In a paper on comparison of lap/shoulder belt vs. lap/shoulder plus supplemental shoulder belt restraint (Ref. 4), the authors describe "The mishap data identified that head injuries were the most frequent sever injury in all mishap categories. Although injury mechanisms could not always be identified from the database, the study of the mishap narratives, the in-depth investigation of 66 mishaps, a hazard analysis of several different HMMWV's, and injury mechanisms all combined to indicate that the vast majority of these head injuries resulted from head impact with interior vehicle surfaces.
Table 1 shows that roll-overs and side impacts combine to cause a disproportionately high number of fatalities.

Crash Mode	Fatalities	Percentage of all Fatalities
Front	23	39
Rollover	26	44
Rear	6	10
Side	4	7

Table 1

Naturally the more hardware is packed inside the vehicle the greater is the chance of the occupants coming in contact with it during a crash situation. This is because even with a restraint system some degree of excursion takes place particularly during side impacts and rollovers.
In this case the vehicle/hardware, the mission and the operator all are contributors to the resulting unsafe condition.
This clearly indicates that there is a need for a new approach to the problem and the answer lies in the vehicle and the hardware.
Tactical vehicles are designed to stay in service for 20 to 25 years. Chances are that more compact communication and navigation gear will be available sooner than newly design vehicles.
The reality is that the military needs to utilize the current fleet to its fullest potential. Also necessary hardware needs to be carried in these vehicles to accomplish the mission. The only alternative is to find ways to make the best of what is available to us

until such time that new hardware and/or vehicles are available.
This can be in the form of elimination of sharp edges, addition of padding to all unused surfaces in close proximity of the occupant body and the use of a more effective restraint system.
Adoption of innovative compact, secure communication technology by which the soldier is able to communicate with levels above and below will effectively eliminate the need for bulky communication gear. Like any technology the communication technology is advancing by the minute and the ideal battlefield communication gear may even be available as we speak, but getting it in the system and in the hands of the soldier is a lengthy process given the criticality and sensitivity of the military communication systems, the need for commonality and simply the existence of billions of dollars worth of systems and equipment currently in the inventory.
However the technology will advance regardless and eventually comes a time for more advanced, multifunction, compact communicators to be introduced into the system.
The same applies to the future tactical vehicles that the Army is currently developing. Now is a the time to consider and incorporate safety in the design and development of the Future Tactical Truck Systems (FTTS), for which the current emphasis seem to be on fuel economy, performance and survivability. Chances are that we most probably follow the same school of thought in system design, i.e. "does the system accomplish its intended mission per Operation Requirements Document ORD?", and ignore the interface requirements of various systems needed to accomplish the mission.
FTTS draft ORD (Ref. 2) lays out the "Emerging Desired Capabilities" without direct reference to safety requirements. In page 3 line 84 (Primary Crew Seats) it clearly describes how many crew seats are required, and that they should provide ergonomic leg, back, shoulder and head support. Also that the driver seat shall be adjustable to support 5th and 95th percentile, but there is no mention of the fact that there should be adequate restraints to keep the occupant firmly in their seat against sudden acceleration/deceleration in all directions. This is a very important requirement or maybe we assume the restraint system comes with the seat? Just to clarify, currently the restraint system in tactical vehicles are of the 3 point variety, however still a good number of vehicles still only have the lap belt. The 3 point restraint system is anchored to the cab structure which varies in it effectiveness depending on the seat adjustment. Perhaps since the restraint system is not integrated to the seat then it should not be mentioned with it and would be covered in another section to do with the cab structure?
The result is that as important occupant restraint system may be it is not treated as a requirement in the ORD.
U.S. Army has lost too many soldiers due to accidents in the latest operation in Iraq. This is a quote

from the USA Today, date April 16, 2003, from an interview with General William Wallace commander of U.S. Army forces in Iraq (Ref. 2) " Among the 121 U.S. military deaths from March 21 through Tuesday (April 15), 35 have been officially classified as accidents. Among the 31 British deaths, 16 have been classified as accidents". Also "Of the 51 total accidental deaths, 28 were in helicopter crashes/collisions and 12 were in vehicle crashes. This war time statistic reinforces the need for safer vehicles, because vehicle accidents do happen so it is prudent to minimize the risk of death or injury by creating a safer vehicle interior as well as introduction of safety technology to prevent or minimize the risk of an accident occurring

Conclusion

Mission, hardware and the operator are the main contributors to safety. Consideration should be given to safety from the beginning in the process for tactical vehicle requirement generation. This requires improvement in communication among Product Management organizations so everyone's present and future requirements are included in the final product design.

Measures need to be taken to neutralize or minimize the safety hazards resulting from deployment of hardware inside the vehicle passenger compartment. Better restraint systems such as one with additional shoulder restraint or the Aviation type 4 point should be used to minimize excursion. Impact absorbing material should be added to all hard objects close to the occupant body will reduce chance of injury.

REFERENCES

1. The following link is for the FTTS draft ORD. http://www.cascom.lee.army.mil/transportation/FTTS/Public/UVworkingcopy.pdf
2. USA Today; McLean, VA; Apr 16, 2003; Steve Komarow;
3. Courtesy of the U.S. Army TACOM Safety Office; George Jarvis; (586) 574 5636
4. Lateral Restraint: Comparison of Lap/Shoulder Belt vs. Lap/Shoulder Plus Supplemental Shoulder Belt Restraint System
Larry A. Sicher, Gary Whitman, John R. Yannaccone, Louis A. D'Aulerio, Alan Cantor (ARCCA, Inc)
Michael Gedeon; U.S. Army TACOM
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Motivators

- Each year many millions of Dollars are lost due to accident related loss of life, productivity and property.
- Safety is most talked about, but with the tendency to be the least practiced.
- Safety often takes the back seat to the performance and mission requirements in the operation of military vehicles.
- There is a relationship between safety, operator, hardware and mission, with the operator as the common denominator.
- We lost far too many lives due to accidents in Iraq.

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FACTS & STATISTICS

- The Army total number of ground, Class A accidents (death or property damage of at least $2 mil), increased by 58%, compared to FY 2002,
- The Army combat vehicle Class A accidents in 2003, increased by 300% compared to 2002, and the 3 year average prior to 2003. (does not include war time statistic) (Source: USASC)
- USA Today, April 16, 2003, from an interview with General William Wallace commander of U.S. Army forces in Iraq

Among the 121 U.S. military deaths from March 21 through Tuesday (April 15), 45 have been officially classified as accidents. Among the 31 British deaths, 16 have been classified as accidents. Also: Of the 51 total accidental deaths, 26 were in helicopter crashes/collisions and 12 were in vehicle crashes.

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Operator, Mission, Hardware

MISSION

OPERATOR

HARDWARE

- Too cramped
- Many hard objects too close
- Promotes fatigue and stress
- Higher chance of injury
- Potential for lower efficiency

Does the job, but is <u>UNSAFE</u> with total disregard for comfort

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Operator, Mission, Hardware

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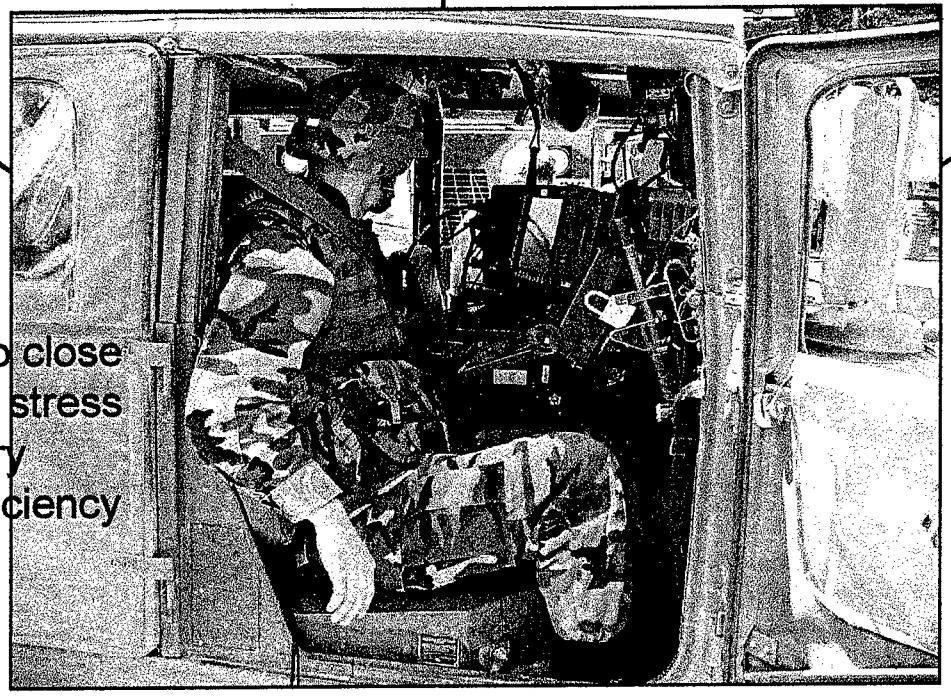

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Taken for Granted

- Do we take safety for granted?
- Should safety be sidelined to mission (War time)
- Should Operation Requirements Documents (ORD) list more safety requirements?
- What is the role of education?
- Built-in safety technology vs. safety awareness education.

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Is Safety a Luxury

Safety professionals report that in spite of today's emphasis on safety by the Army's top leadership, there is still a perception among some young Army leaders that safety is something you have to consider in peacetime missions; but in wartime, safety becomes a luxury. If that is true, and if it is also true that when things get tough, the first things to go are the luxuries - then when war comes, we can no longer afford safety. The question really is, "Can we afford not to consider safety during wartime?" NO

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Make a Conscious Decision

- How much safety technology is too much for tactical vehicles?
- What is the best value for money?
  - Technology
  - Operator education
  - Active enforcement
  - All of the above

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Plan For Safer Future Tactical Truck system

- Explore, develop and incorporate safety technology through collaboration between RDECOM, USASC and the user community.
- Emphasize safety awareness/education
- Enforce safety practice

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OPSEC REVIEW CERTIFICATION

(AR 530-1, Operations Security)

I am aware that there is foreign intelligence interest in open source publications. I have sufficient technical expertise in the subject matter of this paper to make a determination that the net benefit of this public release outweighs any potential damage.

Reviewer: MITCHELL KOZERA GS-13 Team Leader

Name Grade Title

Signature 05/07/03

Signature Date

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