SMSA Spotlight Magazine

NATIONAL ASSOCIATION of STATE MOTORCYCLE SAFETY ADMINISTRATORS

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Modeling the Societal Danger and Driver Danger for Motorcycles on Public Roadways

There are many countermeasures offered by governments and industry to reduce the danger of motorcycling on public roadways. The most enforced countermeasures are the use of helmets and specialized motorcycle endorsements for the driver's license. In the last couple of decades the countermeasures of mandatory basic training and enforcement of sober driving have become popular. Unpopular countermeasures that remain are lowering speed limits and lowering of engine power. And there are others, such as All The Gear All The Time (ATGATT), etc. Of course, we at the National Motorcycle Institute (NMI) want to use the scientific method and not just political acceptance or popularity for evaluating the effectiveness of countermeasures.

I begin with the explanation of some terms. "Risk" can be defined as "the chance of loss." However, this term is too broad for our task. For example, we are not concerned with "loss of motorcycle due to theft." We prefer the term "danger," and use it here to mean "the chance of harm." Then we refine this definition of "harm" to specifically mean "bodily harm." Lastly, we say, "The ultimate bodily harm is death." In other words, once a person is dead, any additional morbidity is of less importance to modeling danger. This is part of the reason we base our motorcycle "models of danger" on the annual fatality counts.

There are two fundamental models of danger that we at NMI use to evaluate the effects of countermeasures. We call these "Societal Danger" and "Driver Danger." Societal danger will include all members of the society and driver danger will only include the drivers. Also, we will match census data to societal danger and vehicle-miles-traveled (VMT) to driver danger. This is because everyone counted in the census is a part of the society and every mile traveled is (currently) caused by a driver. The Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA) provide respected data on fatalities and vehicle use on public roadways and the US Census Bureau (USCB) provides excellent data on population.

We accept the data from these entities as possessing the quality of good veracity. It is hard to be killed on our public roadways and not be counted correctly.

Also, the care that goes into the census is well understood because of the importance of accurate census for the governance of our society.

With such resources available, many models can be developed. However, it takes more than accurate and respected data to make "well constructed" models. Since anyone can divide and multiply any sets of numbers together in any way, many ratios and rates can be calculated. This is "doing the math." I want to make the point that "doing the math" is not science. Just because you can divide the numbers together does not mean you have a model of anything. We call this "dividing the numbers willy-nilly." Scientists often call this "swimming through the math." Some do this "swimming through the math" looking for clues when creating well constructed models. Others simply are not using the scientific method and are wasting time.

SMSA Listserv

Please take advantage of the SMSA Listserv hosted by Oregon State University. The SMSA Listserv is an easy and efficient way to contact your fellow SMSA members with questions relating to Motorcycle Safety and Rider Education. To sign up, visit the SMSA website Members Only section and choose the tab for Listserv. Summaries from past postings are also listed under the Listserv tab.

In order to learn about, then reduce, the danger on public roadways, we must be able to evaluate the effects of countermeasures on danger. In order to measure the effects on the danger, we must have well constructed models for danger. A "well constructed" model is a model where respected data is available for all parts of the model, and that the data must be combined scientifically to become a meaningful model.

Table 1: 2014 USA Fatalities on Public Roadways

2014 USA	Fatalities
Driver of Passenger Vehicle	15,416
Passenger of Passenger Vehicle	5,606
Pedestrian	4,884
Driver of Motorcycle	4,311
Driver of All Other Vehicles	1,038
Bicyclist	720
Passenger of Motorcycle	275
Passenger of All Other vehicles	144
Persons on Personal Conveyances	157
Unknown Occupant Type in a Motor Vehicle-In- Transport	72
Occupant of a Motor Vehicle Not In-Transport	30
Persons In/On Buildings	10
Other Cyclist	6
Occupant of a Non-Motor Vehicle Transport Device	6
Total	32,675

For our first model, societal danger, please refer to Table 1 "2014 USA Fatalities on Public Roadways." In 2014, 32,675 persons in the USA were fatally harmed on public roadways. This 32,675 includes "All Persons" fatally harmed on public roadways, and, of course, "All Persons" fatally harmed were members of society. The well constructed model for the danger to society (a societal danger model) of public roadway users would be to divide the total fatality count of All Persons fatally harmed by the population of the USA, 318,907,401. This gives a 2014 USA rate of 102 fatalities per million population. This rate is somewhat coarse for measuring effects of a particular countermeasure, however, it is well constructed because the people who were fatally harmed are causally related to the population. These two variables, All Fatalities and Population, "go together."

We can refine this societal danger model by narrowing or subdividing the fatalities into vehicle-body-types for Vehicles-In-Transport (VIT). If you think of Table 1 as "All Fatalities from crashes involving one or more VIT," then reducing or narrowing the number of categories leads us to ways to detect the more dangerous categories for society.

Table 2: 2014 USA Fatalities on Public Roadways (Condensed)

2014 USA	Fatalities
Driver of Passenger Vehicle	15,416
Passenger of Passenger Vehicle	5,606
Pedestrian	4,884
Driver of Motorcycle	4,311
Everybody Else	2,458
Total	32,675

Table 2 contains the information from Table 1 with the number of categories reduced to five. As you can see in Table 2, this helps with analyzing which categories represent larger numbers of fatalities. From Table 2 we can see that the vehicle body type "Passenger Vehicles" and "Motorcycles" would be two body types that are reasonable choices to refine our model. For a measure of societal danger from these vehicle body types, we will create a new table with one column as "All Fatalities from crashes involving one or more Motorcycles-In-Transport" and the other column as "All fatalities from crashes involving one or more Passenger Vehicles-In-Transport." Please see Table 3.

Table 3: 2014 USA Fatalities by Person Type from Crashes Involving one (or more) Vehicle (MC or PV)-In-Transport

Person Type	Motorcycle (MC)	Passenger Vehicle (PV)
Driver	4,311	15,416
Passenger	275	5606
Not identified as Driver or Passenger**	61	7,537
All Fatalities	4,647	28,559

With this information we can model Societal Danger from Motorcycle use on public roadways. From Table 3, in 2014, 4,647 persons in the USA were fatally harmed on public roadways in motorcycle crashes. All persons harmed by motorcycles are included, and all these persons are a part of society. The USA population is 318,907,401. The Motorcycle Societal Danger is 14.6 fatalities per million population. Likewise, the Passenger Vehicle Societal Danger is 89.6 fatalities per million population. These rates model Societal Danger from Motorcycles and from Passenger Vehicles, respectively. We suggest these rates are the ones to use when measuring the effectiveness of government programs overall. Changes in these rates are caused by all countermeasures from driver training and road engineering to the popularity of these vehicles.

In addition to Societal Danger Models, we know that Driver Danger Models can be of great value for evaluating particular countermeasures such as specialized license endorsement. Particularly for motorcycling, great effort and expense has been used to attempt to reduce motorcycle driver danger.

Table 4: 2014 USA Driver Fatalities from Crashes Involving one (or more) Vehicles-In-Transport and Vehicle Miles Traveled (VMT)

Vehicle Type	Driver Fatalities	VMT in Millions of Miles	Percentage VMT	Rate = Driver Fatalities per 100 Million VMT
Passenger Vehicles	15,416	2,710,556	89.59	0.569
Motorcycles	4,311	19,970	0.66	21.587
All Other Vehicles	1,038	295,130	9.75	0.352
Total	20,765	3,025,656	100.00	0.686

Per mile, the motorcycle driver fatality rate is 38 times that of the passenger vehicle driver fatality rate.

Referring to Table 4 we can calculate the rates to use when modeling driver danger. There were 4,311 motorcycle driver fatalities in the USA in 2014. We also find in Table 4 that the Vehicle Miles Traveled by motorcycles in 2014 was 19,970 million miles. In order to log a mile traveled by a motorcycle, one needs a motorcycle and a motorcycle driver. The data categories Motorcycle Driver Fatalities and Motorcycle VMT are thus causally related and are appropriate to combine. Driver Fatalities and VMT "go together." The well constructed fatality rate for motorcycle driver fatalities would be 21.6 motorcycle driver fatalities per 100 million motorcycle miles traveled. Likewise, we find 0.569 passenger vehicle driver fatalities per 100 million passenger vehicle miles traveled.

Since these Driver Danger Rates are well constructed and related, we can combine different body-type driver danger rates for even more countermeasure comparison, evaluation, and insight. Using this principle, an additional well constructed danger model, "Relative Motorcycle Driver Danger," can be constructed. This is done by dividing the motorcycle driver fatality rate by the passenger vehicle driver fatality rate. The relative motorcycle driver danger model result being: "The motorcycle driver fatality rate is 38 times that of the passenger vehicle fatality rate, mile for mile." Since these rates and ratios are well constructed, we can say that, in our model, "Driving a motorcycle is 38 times more dangerous than driving a passenger vehicle."

So we know what is a well constructed model. How does one identify poorly constructed models? An example of a poorly constructed, or "willy-nilly," model would be the pedestrian fatalities divided by motorcycle VMT. The result is 24.5 pedestrian fatalities per motorcycle VMT. This is mathematically correct, but not scientifically meaningful. Pedestrians do not cause motorcycle VMT to be traveled nor are a meaningful cause of motorcycle occupant fatalities.

Using this non-meaningful result with any other meaningful or non-meaningful rate will lead to meaningless results. Regretfully, we find these "willy-nilly" rates are published at times. And when published with conviction, the readers, whether intentionally or not, may come to erroneous conclusions.

For Motorcycle Safety programs we now have two well constructed models to assess countermeasures, Societal Danger and Driver Danger. We can measure effectiveness by comparing the rates between years and/or regions where countermeasure were, and were not, in place. The calculation for our Societal Danger base rate is "All Fatalities" divided by "Population" and for the base rate of Driver Danger is the "Driver Fatalities" divided by "Vehicle-Miles-Traveled (VMT)." With these bases we can then compare and combine rates to construct Relative Motorcycle Driver Danger models, and such Societal Danger evaluation tools as the NMI DangerOmeter. Using the important base rates introduced here, I look forward to sharing the reasoning and usefulness of the NMI DangerOmeter soon!

** Not identified as Driver or Passenger of the VIT: This includes everybody else who is not an occupant of the particular vehicle body type, and possibly (although extremely rare) when the occupant of the Vehicle-in-Transport could not be identified as either the driver or the passenger. In practice, the killed occupant is almost always identified as the driver or a passenger.

Joseph Elliott
Executive Director
National Motorcycle Institute

How the Face of Motorcycle Safety Changed for Me

When I started riding motorcycles many years ago, we did it the hard way. We bought a motorcycle. We rode it for a whole summer, at a minimum – sometimes from dawn to dusk. We learned what the Skill Test that we had to pass encompassed and we practiced and practiced. With our permit in hand we rode our registered, inspected, and licensed (all those processes we accomplished) motorcycle, sometimes many miles, to the testing facility. There we did what we'd been practicing all summer well enough to earn that motorcycle endorsement we coveted.

That's a far cry from what riders do today, isn't it? Today, if a person has any inkling that they might want to ride a motorcycle, they can take a state-subsidized class. They can ride someone else's motorcycle in a parking lot for ten hours, take five hours of classroom, and likely be awarded a waiver for a full, unlimited motorcycle endorsement at the DMV.

In the earlier part of my career, I was all about training more and more riders. During my career stint with the U. S. Military Motorcycle Safety Training Programs, I learned that it wasn't about making more motorcyclists – it was about saving lives. So the goal is to give more training to those who are passionate and committed and have their own motorcycles. In 2005, the U. S. Military was losing more Soldiers, Sailors and Marines on their own personal motorcycles than in the Iraqi War effort. These Military Service Members had taken the beginner basic rider course, but they were still dying. In their infinite wisdom, the U. S. Military decided the answer was more training for those who already rode. The Navy, whose motorcycle fatalities were all on sport bikes, required that all sport bike riders take the Military Sport Bike Rider Course. The Army provided the Advanced Rider Course and more involved leadership. The Marine Corps provided all sorts of advanced training, including Track Clinics, Advanced Motorcycle Operator School from CA Superbike School, and Total Control classes.

From 2008 to 2009, after these classes had been put in place, the Navy saw a 61% reduction in motorcycle fatalities; the Army saw a 37% reduction; and the Marine Corps saw a 43% reduction. The Marine Corps also developed a 45-minute video called Semper Ride. It stressed the serious, but exciting, nature of motorcycle riding and showed how valuable dirt riding and track riding could be to increase your street skills. It also demonstrated the exciting elements of riding, including kicking off the premiers of the video with motorcycle free-style and stunt shows. The video and the premier events showed the Soldiers, Sailors, and Marines that leadership "gets it." They understand why we love riding these things.

I think Semper Ride started a change in the Culture of Safety among Military Service motorcycle riders. They started to take responsibility for their own training and safety. I taught a BRC2 class at Quantico which was made up of twelve Marines. They were excellent riders; and, upon questioning them, I learned that they had only taken the BRC prior to this. "How did you get so good?" I asked. Most of them told me that, when they purchased their first bike, they got a friend to ride it to a parking lot. There they stayed for days, practicing what they learned in the beginner class on their big bike. Most stayed for two full days before venturing onto the streets. The remaining riders said they rode their new bike directly to their Base and rode only on the Base for months before venturing out. I asked them why they chose to do it this way. They said, "We have to be safe riders. It's expected of us. We can't be the one who crashes." Definitely a change in the Culture of Safety – the only one I have ever seen in my traffic safety career. Together let's figure out how to adapt this Military Culture of Safety success story to the civilian world.

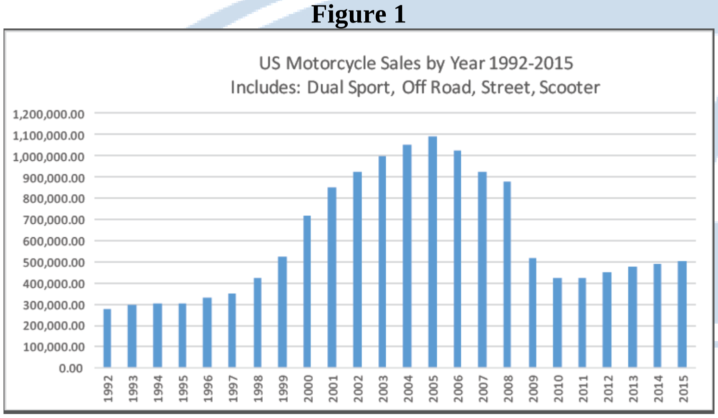
Roberta Carlson
SMSA Supporting Member Representative
Total Control Training

Total Control
Advanced Riding Clinic

Motorcycle Danger by the Numbers

When it comes to motorcycle danger, the numbers tell us some of the story, and the rest of the picture must be drawn with some deductive reasoning. According to the National Highway Traffic Safety Administration (NHTSA), "motorcycles comprise only 3% of registered vehicles and less than 1% of vehicle miles traveled (VMT). Despite their limited presence, motorcycles currently account for nearly 15 percent of all motor vehicle fatalities. This percentage has grown in recent years. Motorcyclist fatalities rose between 1975 and 1980, and then declined steadily to a low of 2,116 in 1997. Fatalities began to rise in 1998 and increased by 151 percent (2,116–5,312) through 2008. Since then (2009–2015), the average annual number of motorcyclist fatalities has been 4,695. During the 1997–2014 timeframe, motorcyclists' share of total motor vehicle deaths rose from 5 percent to 14 percent." This makes motorcycle riding 38 times (3800%) more dangerous than driving a passenger vehicle per mile ridden verses per mile driven as far as fatalities go!

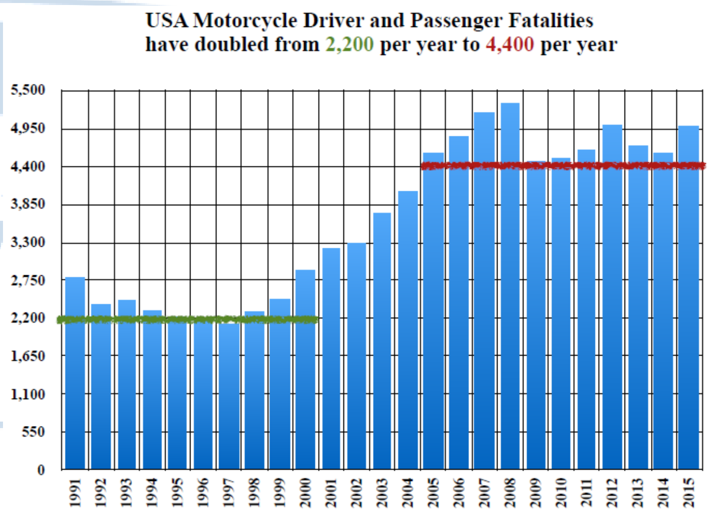
Figure 1



One of the things I do to help better manage the danger of riding is volunteer as a Consulting Motorcycle Expert to the National Motorcycle Institute (NMI). NMI is a nonprofit think-tank, research organization and safety advocacy group. Its mission is to reduce the fatality rate and morbidity (disabling-injury) rate for motorcyclists. To help better understand the "Societal Danger" that motorcycling represents, NMI has put together its DangerOmeter. (http://www.motorcycleinstitute.org/docs/data/dangerometer/dangerometer-by-rank.pdf)

The NMI DangerOmeter is a weighted fatality rate that allows us to rank the states. We use All-Fatalities per Population to model Societal Danger. The DangerOmeter rank is set by using the current 4 year (2011–2014) averages of the All-Fatalities Motorcycle per Population (AFMC/Pop) rate and weighting these with the All-Fatalities Passenger Vehicle per Population (AFPV/Pop) current averages. The results are then sorted from low to high and the state is assigned its number, from 1 through 50.

To try to understand the relative danger of motorcycling as well as why some states are more dangerous than others requires analyzing lots at data and making some informed hypotheses that can be tested. As a start, we can all agree that the more riders in the population, the more fatalities we can expect. Even if the percentages of fatalities goes down, the raw numbers may still go up. In Figure 1, you can see the new motorcycle sales in the U.S. as reported by WebBikeWorld.com. You will notice the "boom years" of 2004–2005, when nearly 1.1 million motorcycles were reported sold in the U.S.A. This had a lot to do with the housing bubble when many Americans (including yours truly) used the rising equity of their homes as their bank. This allowed folks to take cash out and buy things like motorcycles.



When the housing bubble burst, there was a similar crash in new bikes sales, exactly as one would expect. Figure 2 shows the total of what NHTSA calls "Motorcycle Driver Fatalities" from 1991–2014. Motorcycle "Drivers" is NHTSA-speak for the person operating the vehicle, and does not include deaths to passengers, pedestrians, bicyclists, car drivers, etc. The reason I think this is a good way to look at danger is because by limiting the fatalities to "drivers" allows us to look at the success rate of licensing programs from state to state. Licensing programs include rider training (the major contributor to new licensed riders by way of a "license waiver" offered for successful completion of a riding course). They also include DMV testing and to a somewhat lesser extent, contributions by law enforcement and the judicial branch of government.

As you can see total Motorcyclist Fatalities has just about doubled from 2000–4000 in the last decade! Unfortunately, even though sales are significantly down from the boom years, fatalities have continued to stay at extremely high levels. In fact, with the latest data now coming in from the Governors Highway Safety Association, there was another 10% average increase in motorcycle fatalities in 2015 nationwide. The good news is there were some interesting outliers I'd like to look at.

For many years I have postulated that the more beginner rider training a state does, the higher the fatality rates will be. I believe this is due to 1) Increasing the total rider population 2) The kinds of incentives that state programs initiate to attract the wrong kind of riders and 3) Lower quality training/standards verses countries like Germany, Japan and England. With my company currently the program manager and curriculum vendor for California, these factors weigh heavy on my mind and we have gone to great lengths to change the culture of safety in our state.

To understand the first point let's compare two states who had extremely high and low training and fatality rates this year. Florida had a "record" year of 616 motorcyclist fatalities—an increase of 138 fatalities from 2014. This is the second largest training program in the country (behind only California) and is one of the few with mandatory beginner rider training to get your license. Florida trained more new riders in 2015 than in any previous year.

By contrast, due primarily to program management changes, Indiana trained approximately 33% fewer riders in 2015 verses 2014 and had a 13% decrease in fatalities (16 fewer deaths). This is with the same curriculum but significantly less training available.

As you've previously heard at last year's SMSA Symposium, in my state of California we had a complete change in management, standards, curriculum and philosophy of training last year. The new philosophy includes being honest with prospective students about the danger and difficulty of riding, and the importance of follow-on training and wearing protective riding gear. I'm proud to say we experienced the largest reduction of fatalities in the country—60 fewer deaths—for a 11.5% decrease in the first year.

We are the only state besides Idaho that requires motorcycle instructors to wear a motorcycle-specific (or any other type) of jacket as part of their protective gear any time the students see them riding. This includes riding to and from the range as well as riding any demonstrations. We feel it is hypocritical and sends a mixed message to talk about the importance of riding gear if the instructors don't practice what they preach. Actions always speak louder than words. We also trained a record number of civilian instructors and students in the state in intermediate and advanced training courses on their own bikes.

What makes this even more remarkable is that this all happened the same year total traffic safety fatalities (including cars, trucks, busses, etc.) in California increased 4%, according to the National Safety Council. This means the relative societal danger of riding became significantly safer compared to previous years. And we have plenty more safety initiatives that have us working closer with DMV, law enforcement and the judicial system to decrease fatalities even further.

Of course, I'm the first to admit that rider training is only one piece of the safety puzzle and that rider behavior is influenced by many factors. Similarly, one-year fluctuations mean less than three-plus year trends, so stay tuned for more data as it becomes available.

Unfortunately, the incentives issue has caused many state programs to increase beginner training numbers (the worst possible metric) by lowering the barrier to entry to our sport by either offering free or heavily subsidized beginner rider training, or not being honest about the dangers and difficulty of riding. I don't think state motorcycle safety programs should be in the business of "promoting" the sport. That's the job of private business and tourism bureaus. Rather, they should be brutally honest with prospective riders and spend their resources promoting follow-on training for existing riders on their own bikes, and paying more than lip service to lifelong learning.

The military did just that in 2009 by making follow-on and refresher training a requirement and saw 37%–61% reductions in fatalities, depending on the service. We can do the same. But it's going to take organizations like SMSA to be the opinion leaders in our riding communities and make safety cool so the others will embrace it. Perhaps only then will motorcycle riding begin to get anywhere near as statistically safe as driving a car.

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Distributed Learning and Training

What is distributed learning and training mean to our community?

The concept of distributing learning across different knowledge delivery systems and modalities is not as new and innovative as one might think. Correspondence courses were used extensively prior to the robust proliferation of digital communications—via the internet. For my purposes of this article I define Distributed Learning and Training (DLT) as any means or practice to convey knowledge and development of skills for learners; however, the modality of the learning is less important for my discussion. My emphasis is on the distribution of skills practice across multiple and shorter periods of time versus massed practice that is typical of many training and education disciplines. By scheduling shorter training periods, in motorcycle driver training, we should see fewer training mishaps, improved student satisfaction, and better skill retention after training.

The past and today

Distributed training and practice, in many fields, continues in very near similar fashion of the tradition. Athletes, especially serious competitors, distribute their training and practice across months or years. Routine training, supported by continual self-practice, are the hallmarks of professional and semi-professional performers. One must use caution when developing long term skills training and practice plans for the learner; because, repetition and time on task must have precision and accuracy of student performance to prevent training scars (undesirable results). From an historical perspective the traditional martial arts is a good example of distributed practice. The typical US martial arts model, while a business model, includes repeat and short duration practice sessions. The Master's intent is to develop a semi-autonomous motor-skill (a strike, block, or kick) that is developed through repetitive motions; however, any martial arts student knows strength and speed has no value without precision. Each movement requires precise repeatability—thousands of times before the skill begins any further development. The martial arts model, then and now, serves the practitioner and master well.

Applications of DLT in dissimilar fields

During my years within military training programs, while active-duty and as a contractor, I continuously studied and analyzed anecdotal and empirical evidence related to training and post-training mishaps. I wanted to identify probable causes of training mishaps in military, law enforcement, and civilian programs. Initially I suspected program training methodology and practices (how training is conducted) but soon discovered the methods and practices are universally similar and some programs experienced significantly lower training mishap events. While reviewing reported training mishaps from military, law enforcement, and civilian traffic or firearm programs—in Georgia—I noticed mishaps occurred mostly in the months of May through September. There was one exception in my review, a civilian firearms training school had notably less training mishaps reported. I interviewed the director of training of the civilian training program and discovered the curricula was identical or similar to the other schools—military, law enforcement, or civilian. The only significant difference at the low mishap school was the maximum hours of hands-on training did not exceed two hours. The two hour training limit was not by courseware design but was scheduled with two hour training increments because of the lease agreement at the shooting facility. Eureka! I conducted a literature review of training and skills development and focused on how other training communities mitigated training mishaps and the possibility of applying those lessons to motorcycle driver training. I reviewed the following industries: recreational scuba diving, general aviation, sport aviation, powered parachuting, and introduction level recreational shooting. Most of the reviewed training communities, generally, limited skills development between one and no more than three hours!

Distributed practice and skill development: The first test and collection anecdotal data

The first test of distributing training included students attending civilian Combat Pistol courses. I studied two scheduling schemes that used the same instructors and course of instruction. The course, Combat Pistol I, includes two hours of classroom lecture and six hours of firearms skills development and practice—advertised as a one day course. The test schedule altered the traditional eight hour one-day course by scheduling the contact hours across two days (5 hours and 3 hours). I measured both groups of students in the area of gun handling performance and shooting accuracy and precision. I predicted student skill, within the one-day course, would begin to diminish after the third hour on the firing range while the test group would maintain or improve skill on both day one and two. The predicted results occurred as expected. The most significant degradation in observable skill, in the one-day group, was trigger control and trigger reset—

both fine motor-skills. Gross motor-skills diminished slightly and mostly manifest as poor form while drawing the handgun from the holster for presentation and shooting. Specifically, the handgun presentation has five distinct stages—student fatigue seemed to cause sloppiness with gun presentation and the tired students tended to blend the five stages thus increasing unnecessary motions resulting in reduced precision and accuracy performance.

By applying the same scheduling concept, in motorcycle driver training, I suggest we will see a reduction in training mishaps, increased student satisfaction, and longer term efficacy in post-training driver performance. My discovery or findings are by no means conclusive or complete—I encourage all of you to look into distributed and shorter duration training schedules and share with our community.

Hector Eide
Program Manager
Pennsylvania
Motorcycle Safety Program

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2017 SMSA National Training Summit in Vermont

The 2017 SMSA Conference will be held September 27-30, 2017 in Burlington, Vermont; hosted by the Vermont DMV Rider Education Programs.

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SMSA welcomes our first SMSA Supporting Corporate Partner: **the Motorcycle Safety Foundation (MSF)**.

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