

# A Short Course in External Ballistics

(Well, ok. Maybe not so short.)

There is a lot of misleading information and myth flying around ("bull-istics") on the subject of the external ballistics. The tables below will hopefully shed some light on how that bullet really travels once you've pulled the trigger. All tables are rounded to the nearest 10 feet per second and drops are rounded to two places, unless I am trying to show small increments. Greater precision is meaningless in the "real" world. Even for the best of marksman a 1/2 minute of angle difference is effectively meaningless at realistic ranges. The majority of information is presented on rifle cartridges but the principles hold true for shotgun and pistol as well.

## Remember Fr. Frog's Rules of External Ballistics:

- 1) There ain't no magic bullets!
- 2) Divide the range at which someone claims to have shot their deer by 4 to get the real range.
- 3) Always get as close as possible.
- 4) Don't believe manufacturer's claims.
- 5) In the battle between velocity and accuracy, accuracy always wins.
- 6) Most gun writers are pathological liars.

Please note that this a moderately long page and runs about 14 screens worth at 800 x 600 screen resolution, so you might want to print it out. (Landscape orientation works best.) MS FrontPage says 20 seconds to load at 56.6k.

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## The Bullet's Path

Many people believe that bullets fly in a straight line. This is untrue. They actually travel in a parabolic trajectory or one that becomes more and more curved as range increases and velocity drops off. The bullet actually starts to drop when it leaves the firearm's muzzle. However, the centerline of the bore is angled slightly upward in relation to the line of the sights (which are above the bore) so that the projectile crosses the line of sight on its way up (usually around 25 yards or so) and again on its way down at what is called the zero range.

Terms relating to external ballistics include:

**Back Curve** - This is that portion of the bullets trajectory that drops below the critical zone beyond the point blank range. Past this point the trajectory begins to drop off very rapidly with range and the point of impact becomes very difficult to estimate.

**Ballistic Coefficient** - This is a number that relates to the effect of air drag on the bullet's flight and which can be used to later predict a bullet's trajectory under different circumstances through what are called "drag tables." Drag tables, or "models" apply only to a particular bullet, so using them to predict another bullet's performance is an approximation. The most commonly used drag model is the  $G_1$  model (sometimes referred to--not really correctly--as  $C_1$ ) which is based on a flat-based blunt pointed bullet. The "standard" bullet used for this model has a ballistic coefficient of 1.0. A bullet that retains its velocity only half as well as the model has a ballistic coefficient of .5. The  $G_1$  model provides results

close enough to the actual performance of most commercial bullets at moderate ranges (under about 500 yards) that it is commonly used for all commercial ballistics computation.

*A word to the wise. Many manufacturer give rather generous BCs for their bullets because: a) they want to look good--high BCs sell bullets; b) they were derived by visual shape comparison rather than actual firing data; or c) they were derived from short range firings rather than long range firings (which are more difficult to do). You should confirm your calculations by actual firing if you require exact data. Several manufactures have recently "readjusted" some of their BCs to more closely conform to actual firing data. For a more in-depth discussion of ballistic coefficients see the section below.*

**Bore Centerline** - This is the visual line of the center of the bore. Since sights are mounted above the bore's centerline and since the bullet begins to drop when it leaves the muzzle the bore must be angled upwards in relation to the line of sight so that the bullet will strike where the sights point.

**Bullet Trajectory** - This is the bullet's path as it travels down range. It is parabolic in shape and because the line of the bore is below the line of sight at the muzzle and angled upward, the bullet's path crosses the line of sight at two locations.

**Critical Zone** - This is the area of the bullet's path where it neither rises nor falls greater than the dimension specified. Most shooters set this as  $\pm 3"$  to  $4"$  from the line of sight, although other dimensions are sometimes used. The measurement is usually based on one-half of the vital zone of the usual target. Typical vital zones diameters are often given as:  $3"$  to  $4"$  for small game, and  $6"$  to  $8"$  for big game and (Gasp!) anti-personnel use.

**Initial Point** - The range at which the bullet's trajectory first crosses the line of sight. This is normally occurs at a range of about 25 yards.

**Line of Sight** - This is the visual line of the aligned sight path. Since sights are mounted above the bore's centerline and since the bullet begins to drop when it leaves the muzzle the bore must be angled upwards in relation to the line of sight so that the bullet will strike where the sights point.

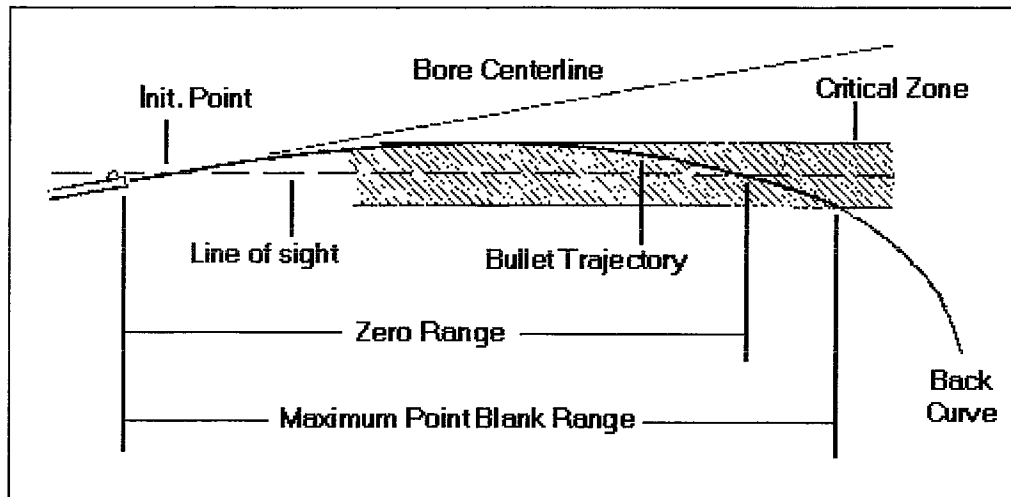
**Maximum Ordinate** - This is the maximum height of the projectile's path above the line of sight for a given point of impact and occurs somewhat past the halfway point to the zero range and it is determined by your zeroing range.

**Maximum Point Blank Range** - This is the farthest distance at which the bullet's path stays within the critical zone. In other words the maximum range at which you don't have to adjust your point of aim to hit the target's vital zone. Unless there is some over riding reason to the contrary shots should not generally be attempted much past this distance. In the words of the Guru, "It is unethical to attempt to take game beyond 300 meters." If you do, you should write yourself a letter explaining why it was necessary to do so. An *approximate* rule of thumb says that the maximum point blank range is approximately your zero range plus 40 yards.

**Mid-range Trajectory** - This is the height of the bullets path above the line of sight at half way to the zero range. It does not occur at the same range as the maximum ordinate height which can be greater.

**Minute of Angle (MOA)** - A "minute" of angle is  $1/60$  of a degree which for all practical purposes equates to 1 inch per 100 yards of range. Thus 1 MOA at 100 yards is 1 inch and at 300 yards it is 3 inches. The term is commonly used to express the accuracy potential of a firearm.

**Zero Range** - This is the farthest distance at which the line of sight and the bullet's path intersect.



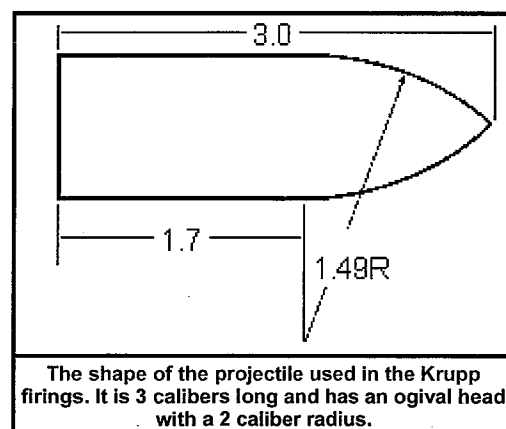
The bore's angle in relation to the line of sight is exaggerated in this drawing for clarity.

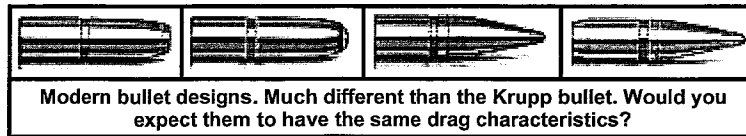
### A Brief Discourse on Ballistic Coefficients

This is probably the best article I have read on ballistic coefficients. It was written by Jim Ristow of Recreational Software, Inc. and is reprinted here with his permission. It was designed to encourage a discussion about ballistic coefficients and to explain why good BCs are crucial to getting accurate results from ballistic software. The illustrations and tables were not part of the original article.

#### A Little History

In 1881 Krupp of Germany first accurately quantified the air drag influence on bullet travel by test firing large flat-based blunt-nosed bullets. Within a few years Mayevski had devised a mathematical model to forecast the trajectory of a bullet and then Ingalls published his famous tables using Mayevski's formulas and the Krupp data. In those days most bullet shapes were similar and airplanes or missiles did not exist. Ingalls defined the Ballistic Coefficient (B.C.) of a bullet as it's ability to overcome air resistance in flight indexed to Krupp's standard reference projectile. The work of Ingalls & Mayevski has been refined many times but it is still the foundation of small arms exterior ballistics including a reliance on BCs.





By the middle of the 20th century rifle bullets had become more aerodynamic and there were better ways to measure air drag. After WWII the U.S. Army's Ballistic Research Lab (BRL) conducted experiments at their facility in Aberdeen, MD to remeasure the drag caused by air resistance on different bullet shapes. They discovered air drag on bullets increases substantially more just above the speed of sound than previously understood and that different shapes had different velocity erosion due to air drag. In 1965 Winchester-Western published several bullet drag functions based on this early BRL research. The so-called "G" functions for various shapes included an improved Ingalls model, designated "G<sub>1</sub>". Even though the BRL had demonstrated modern bullets would not parallel the flight of the "G<sub>1</sub>" standard projectile, the "G<sub>1</sub>" drag model was adopted by the shooting industry and is still used to generate most trajectory data and B.C.'s. Amazingly, the "G<sub>1</sub>" standard projectile is close to the shape of the old blunt-nosed, flat-based Krupp artillery round of 1881!

The firearms industry has developed myriad ways to compensate for this problem. Most bullet manufacturers properly measure velocity erosion then publish B.C.'s using an "average" of the calculated G<sub>1</sub> based B.C.'s for "normal" velocities. In other words, the only spot on the G<sub>1</sub> curve where the model is correct is at the so-called "normal" or average velocity. These B.C.'s are off slightly at other velocities unless the bullet has the same shape, and therefore the same drag as the standard G<sub>1</sub> projectile.

Some ballistic programs adjust the B.C. for velocities above the speed of sound, others use several B.C.'s at different velocities in an effort to correct the model. While these approaches mitigate some of the problem, B.C.'s based on G<sub>1</sub> still cannot be correct unless the bullet is of the same shape as the standard projectile. Also, the change to air drag as a function of velocity does not happen abruptly. Drag change is continuous with only small variation immediately above or below any point along the trajectory. Programs that translate the Ingalls tables directly to computer or use multiple B.C.'s can produce velocity discontinuities when drag values change abruptly at pre-determined velocity zones. The resulting rapid changes to ballistic coefficient do not duplicate "real world" conditions.

### The Solution

Shooting software is finally appearing based on methods used in aerospace with drag models for different bullet shapes. Results are superior to traditional "G<sub>1</sub> fits everything" thinking, but now shooters must learn B.C.'s are different for each model.

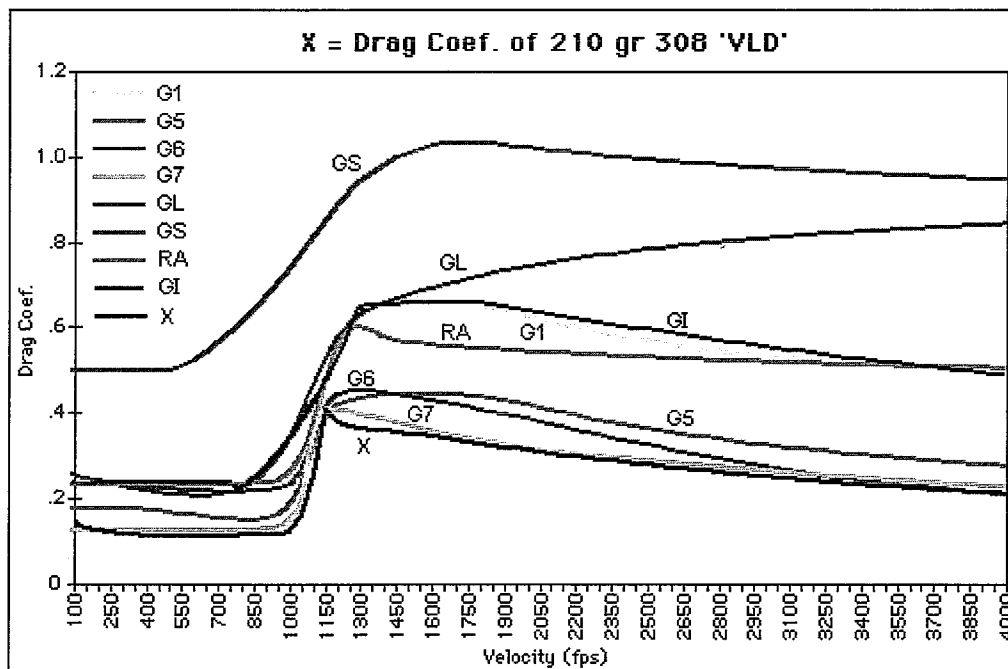
This is a scary proposition for most bullet companies who know many shooters pick bullets based only on their B.C.'s. For example, A boat tailed bullet with a G<sub>1</sub> based B.C. of .690 may actually have a G<sub>7</sub> based B.C. of only .344, since the G<sub>7</sub> drag model accurately describes its performance. But, everyone "knows" that .690 is "better" than .344. However, using the wrong drag model will yield trajectory data that indicates incorrect drop. Fortunately the differences only become important at very long range (>500 yards) but there is a difference. As an example the GI M80 Ball bullet (149 gr FMJ boat tail) has a verified G<sub>7</sub> BC of .195. The commercial equivalents of this bullet are listed as having a G<sub>1</sub> BC of between .393 and .395. You can see the differences in the plotted trajectories using both the G<sub>1</sub> and G<sub>7</sub> values and a program that handles both types.

	G1 = .393	G7 = .195

Range	Vel.	Path	Vel.	Path
0	2750	-1.5	2750	-1.5
100	2522	4.8	2520	4.9
200	2306	5.70	2302	5.7
300	2100	0.00	2094	0.00
400	1905	-13.6	1898	-13.7
500	1722	-36.8	1710	-37.0
600	1553	-71.8	1530	-72.3
700	1401	-121.3	1360	-122.6
800	1269	-188.4	1200	-191.7
900	1161	-277.2	1074	-285.1
1000	1078	-391.8	1014	-408.4

Modern ballistics uses the coefficient of drag (C.D.) and speed of sound rather than traditional Ingalls/Mayevski/Sciacci  $s$ ,  $t$ ,  $a$  &  $i$  functions. This avoids velocity discontinuities and when combined with a proper drag model is far more accurate to distances beyond 1000 yards. A by-product of modern ballistics research is that the C.D. can be estimated fairly accurately from projectile dimensions and used to define custom drag models for unusual bullet shapes. (See caveat below.)

The drawing below shows how the various drag models vary.



Note the difference between the G1 and the G5, G6, and G7!

The Coefficient of Drag for a bullet is simply an aerodynamic factor that relates velocity erosion due to air drag, air density, cross-sectional area, velocity, and mass. A simpler way to view C.D.'s are as the "generic indicator" of drag for any bullet of a particular shape. Sectional Density is then used to relate these "generic" drag coefficients to bullet size. The "Sectional Density" of a bullet is simply its weight in pounds divided by its diameter squared.

$$\text{Sectional Density} = (\text{Wt. in Grains}) / (7,000 * \text{Dia.} * \text{Dia.})$$

You can see from the formula that a 1 inch diameter, 1 pound bullet (7,000 gr.) would produce a sectional density of 1. Indeed the standard projectile for all drag models can be viewed as weighing 1

pound and having a 1 inch diameter.

Another term occasionally found in load manuals is a bullet's "Form Factor". The form factor is simply the C.D. of a bullet divided by the C.D. of a pre-defined drag model's standard projectile.

$$\text{Form Factor} = (\text{C.D. of any bullet}) / (\text{C.D. of the Defined 'G' Model Std. Bullet})$$

### So What Is A Ballistic Coefficient?

Ballistic Coefficients are just the ratio of velocity retardation due to air drag (or C.D.) for a particular bullet to that of its larger 'G' Model standard bullet. To relate the size of the bullet to that of the standard projectile we simply divide the bullet's sectional density by it's form factor.

$$\text{Ballistic Coefficient} = (\text{Bullet Sectional Density}) / (\text{Bullet Form Factor})$$

From these short formulae it is evident that a bullet with the same shape as the 'G' standard bullet, weighing 1 lb. and 1 inch in diameter will have a B.C. of 1.000. If the bullet is the same shape, but is smaller, it will have an identical C.D., but a form factor of 1.000 and a B.C. equal to it's sectional density.

The following are the most common current drag models used in ballistics:

**G1.1** - Standard model, flat based pointed bullet - 3.28 calibers in length, with a 1.32 caliber length nose, with a 2 caliber (blunt) nose ogive

**G2** - Special model for a long conical point banded artillery projectile - 5.19 calibers long with a .5 caliber 6° boat tail. Not generally applicable to small arms.

**G5.1** - For Moderate (low base) boat tails - 4.29 calibers long with a .49 caliber 7° 30' boat tail with 2.1 caliber nose with a 6.19 caliber tangent nose ogive

**G6.1** - For flat based "spire point" type bullets - 4.81 calibers long with a 2.53 caliber nose and a 6.99 caliber secant nose ogive

**G7.2** - For "VLD" type or pointed boat tails - 4.23 calibers long with with a .6 caliber long 7° 30' Tail Taper and a 2.18 caliber long nose with a 10 caliber tangent nose ogive. Most modern US military boat tailed bullets match this model.

**G8.1** - Flat base with similar nose design to G7 - 3.64 calibers long with a 2.18 caliber long nose and a 10 caliber secant nose ogive. The US M2 152 gr .30 cal bullet matches this drag model. Close to the G6 model.

**Gs** - For round ball - Based on 9/16" spherical projectiles as measured by the BRL. Larger and smaller sphere characteristics are effectively identical.

**RA4** - For 22 Long Rifle, identical to G1 below 1400 f/s

**GL** - Traditional model used for blunt nosed exposed lead bullets, identical to G1 below 1400 f/s

**G1** - Converted from the original Ingalls tables. Essentially G1

**Gc** - 3 caliber long flat nosed cylinder. Identical to G1 below 1200 f/s

To see what shapes these drag models are based upon, [click here](#).

### For Best Accuracy, Calculate Your Own Coefficients!

Accurate B.C.'s are crucial to getting good data from your exterior ballistics software. A good ballistic program should be able to use two velocities and the distance between them to calculate an exact ballistic coefficient for any of the common drag models. While you should really simultaneously measure the velocities at the 2 points you can do very good work by measuring a *minimum* of 5 shots at the near and far ranges and average each group.

This method of calculating a B.C. is preferred for personal use and can be used to duplicate published velocity tables for a bullet when the coefficient is unknown or to more accurately model trajectories achieved from your own firearm. A lot has changed in shooting software. If your software is more than two years old, chances are it does not employ the latest modeling techniques or calculate B.C.'s and even some of the newest software is not perfect as you can see from the next section.

To order RSI's Shooting lab software you go to [www.shootingsoftware.com](http://www.shootingsoftware.com) . Please tell him Fr. Frog sent you.



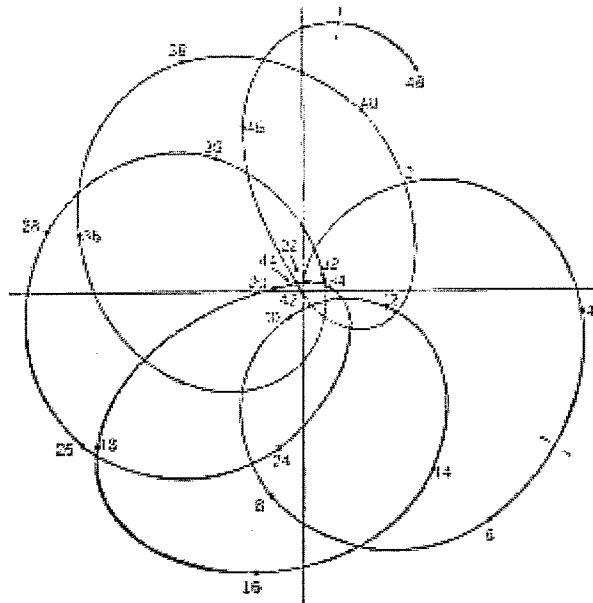
Bullet pictures courtesy Hornady Mfg.  
Drag curves courtesy Jim Ristow

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### Some Caveats

We mentioned that CD can be estimated fairly well from certain bullet dimensions. However, because of the effects of bullet wobble (precession due to rotation), nose tip radius or flatness, nose curvature and boat tail, boundary layer interaction from cannelures and land engraving, etc. (all of which affect the wave drag, base drag and friction drag of the bullet differently) it is really impossible to predict with total accuracy the actual CD vs. Mach number. Also, while a ballistic coefficient can be computed from velocity measurements at two points, differences in bullet wobble diminishes the validity of chronograph testing for BC change over separate series of different *muzzle* velocities--it needs to be done by separate measurements at different ranges for each shot. Why? Read on.

An elongated bullet, as opposed to a round ball, is inherently unstable aerodynamically. When made stable gyroscopically by spinning, its center-of-gravity will follow the flight path. However, the nose of the bullet stays above the flight path ever so little just because the bullet has a finite length and generates some lift. This causes the bullet to fly at a very small angle of attack with respect to the flight path. The angle of attack produces a small upward cross flow over the nose that results in a small lift force. The lift force normally would cause the nose to rise and the bullet to tumble as the nose rose even more. That is where the spin comes in and causes the rising nose to precess about the bullet axis. When the spin is close to being right for the bullet's length, the precessing is minimized and the bullet "goes to sleep" If it is too slow the bullet will not be as stable as it should. (That is why Jeff Cooper says it's wrong to shoot groups at 100 yards for accuracy testing and suggests 300 yards. If your twist isn't right for the bullet used your group size will be larger at long ranges than would be expected by extrapolation of 100 yard data due to bullet wobble.)



Of course, any other disturbing force such as a side wind gust could cause a difference in bullet nose precession but the effect would be quite small for a properly spin stabilized bullet. Most of the lift force is on the nose of the bullet and is proportional to the square of the bullet velocity as well as the nose shape and length. The new long-nosed bullets for long range match shooting can generate quite a bit more lift occurring farther ahead of the center- of-gravity and can produce a nasty pitch-up moment. That is why they require a faster than normal twist to stabilize them. Pistol bullets, being relatively short and with little taper to the nose, require a slower spin for stability.

Let's look at the rotational speed of a bullet. The formula for computing the rotational speed of a bullet is

$$R = (12/T) * V$$

where

T = Twist

V = Velocity in f/s

R = Rotations per second

Now consider a bullet chronographed at about 3000 f/s muzzle velocity fired from a rifle with say a 10" twist. It is rotating at around 3600 revolutions per second (216,000 rpm). Let the flight velocity decay to 2000 f/s. Now what is the bullet rotational speed? It doesn't fall off much because the only things slowing it down are inertia and skin friction drag which is pretty low, so the rotational velocity is only slightly slower than 3600 rps. Then chronograph an identical bullet from the same rifle, this time with a muzzle velocity of 2000 f/s. Its rotational velocity will be 2400 rps. Its stability will be different from the bullet fired at 3000 f/s and allowed to slow down to 2000 f/s. They will not have the same drag at 2000 f/s although the bullets are identical. Therefore, two identical bullets fired from the same rifle at different velocities, will not have the same drag coefficient or ballistic coefficient just because of the way the measurements were taken. There are times when test data does not mean what you think it does. Again, radar range testing is the only way to fly for trustworthy bullet drag data. [I am indebted to Lew Kenner for this lucid description of bullet stability.]

Another factor is that it is not necessarily true that the drag coefficient of a particular bullet is



proportional to that of another bullet of the same design across the Mach number range, but this is what a ballistic coefficient assumes.

Something else to worry about is the effect of the bullet tip shape/condition on the ballistic coefficient. Because modern bullet have soft points they are subject to damage and manufacturing tolerances that can alter the BC from bullet to bullet and across otherwise similar bullets, although this affect is small unless there is a great deal of deformation.

For truly accurate results, individual bullet characteristics need to be measured on radar ranges as is done by the military--much too expensive a procedure for the commercial bullet industry who doesn't really care about great accuracy in BC calculations--and the drag model from those measurements applied *only* to the particular bullet tested. (If you have a spare \$100,000 + and would like to buy me such a setup, let me know.)

The good news is that for normal rifle ranges the drag coefficients and ballistic coefficients can work satisfactorily for most purposes--so let's proceed.

[Click here to continue](#)

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### Disclaimer

As far as I know all the information presented above is correct and I have attempted to insure that it is. However, I am not responsible for any errors, omissions, or damages resulting from the use or misuse of this information, nor for you doing something stupid with it. (Don't you hate these disclaimers? So do I, but there are people out there who refuse to be responsible for their own actions and who will sue anybody to make a buck.)



Updated 2006-06-05



# Association of Firearm and Tool Mark Examiners

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ASSOCIATION OF FIREARM AND TOOLMARK EXAMINERS, I PLEDGE  
 L AND FAIR INVESTIGATION OF THE FACTS WITH WHICH I AM  
 FOR AN OPINION STRICTLY IN ACCORDANCE WITH THE INFORMATION  
 OBTAINED FROM MY EXAMINATION OF THE FACTS AND PHYSICAL EVIDENCE, AND ONLY TO  
 THE EXTENT JUSTIFIED BY SUCH INFORMATION, TO RENDER AN OPINION ONLY WITHIN MY  
 FIELD OF COMPETENCE, TO MAINTAIN AN ATTITUDE OF INDEPENDENCE, IMPARTIALITY,  
 AND CALM OBJECTIVITY, IN ORDER TO AVOW PERSONAL OR PROFESSIONAL INVOLVEMENT  
 IN THE PROCEEDINGS, TO CONSTANTLY SEEK TO IMPROVE MY PROFESSIONAL  
 CAPABILITY BY EXPERIMENTATION AND STUDY AND TO IMPROVE STANDARDS AND  
 TECHNIQUES IN THE FIELD BY MAKING AVAILABLE THE BENEFITS OF MY PROFESSIONAL  
 ATTAINMENTS.

### INTRODUCTION

This code is intended to as a guide to the ethical conduct of individual workers in the field of firearms and toolmark examination. It is not to be construed that these principles are immutable laws, nor that they are all-inclusive. Instead, they represent general standards which each worker should strive to meet. It is to be realized that each individual case may vary, just as does the evidence with which the examiner is concerned, and no set of guides or rules will precisely fit every occasion. A failure to meet or maintain certain of these standards will justifiably cast doubt upon an individuals fitness for this type of work. Serious or repeated infractions of these principles may be regarded as inconsistent with membership in the Association.

It is the duty of any person practicing the profession of firearms and toolmark examination to serve the interests of justice to the best of his ability at all times. He will use all of the scientific means at his command to ascertain all of the significant physical facts relative to the matters under investigation. Having made factual determinations, he must then interpret and evaluate his findings. In this he will be guided by experience and knowledge which, coupled with a serious consideration of his analytical findings and the application of sound judgment, may enable him to arrive at opinions and conclusions pertaining to the matter under study. These findings of fact and his conclusions and opinions should then be reported with all the accuracy and skill of which the examiner is capable.

In carrying out these functions, the examiner will be guided by those practices and procedures which are generally recognized within the profession to be consistent with a high level of professional ethics. The motives, methods and actions of the examiner shall at all times be above reproach, in good taste and consistent with proper moral conduct.

### **I. SCIENTIFIC METHOD**

- A. The true scientist will make adequate examination of his material, applying those tests essential to proof. He will not, merely for the sake of bolstering his conclusions utilize unwarranted and superfluous tests in an attempt to give apparent greater weight to his results.

- B. The modern scientific mind is an open one, incompatible with secrecy of method. Scientific analyses will not be conducted by 'secret processes', nor will conclusions in case work be based upon such tests and experiments that will not be revealed to the profession.
- C. A proper scientific method demands reliability of validity in the materials analyzed. Conclusions will not be drawn from materials which themselves appear unrepresentative, atypical or unreliable.
- D. A truly scientific method requires that no generally discredited or unreliable procedure be utilized in the analysis.
- E. The progressive worker will keep abreast of new developments in scientific methods and, in all cases, view them with an open mind. This is not to say that he need not be critical of untried or unproved methods, but he will recognize superior methods if and when they are introduced.

## II. OPINIONS AND CONCLUSIONS

- A. Valid conclusions call for the application of generally accepted techniques.
- B. Tests are designed to disclose facts and all interpretations shall be consistent with that purpose and will not be knowingly distorted. Where appropriate to the correct interpretation of a test, experimental controls shall be made.
- C. Where test results are inconclusive or indefinite, any conclusions drawn shall be fully explained.
- D. The examiner is unbiased and refuses to be swayed by evidence or matters outside the specific materials under consideration. He is immune to suggestion, pressures and coercions inconsistent with the evidence at hand, being interested only in ascertaining facts.
- E. Scientific method demands that the individual be aware of his own limitations and refuse to extend himself beyond them. It is both proper and advisable that the examiner seek knowledge in new fields; he will not, however, be hasty to apply such knowledge before he has had adequate training and experience.
- F. Where test results are capable of being interpreted to the advantage of either side of a case, the examiner will not choose that interpretation favoring the side by which he is employed merely as a means of justifying his employment.
- G. It is both wise and proper that the examiner be aware of the various possible implications of his opinions and conclusions and be prepared to weigh them, if called upon to do so. In any case; however, he will clearly distinguish between that which may be regarded as scientifically demonstrated fact and that which is speculative.

## III. COURT PRESENTATION

- A. The ethical expert does not take advantage of his privilege to express opinions by offering opinions on matters within his field of qualification

to which he has not given formal consideration.

- B. Regardless of legal definitions, the examiner will realize that there are degrees of certainty represented under the single term of "expert opinion". He will not take advantage of the general privilege to assign greater significance to an interpretation than is justified by the available data.
- C. Where circumstances indicate it to be proper, the expert will not hesitate to indicate that, while he has an opinion derived of study and judgment within his field, the opinion may lack the certainty of other opinions he might offer. By this or other means, he takes care to leave no false impressions in the minds of the jurors or the court.
- D. The expert will avoid unclear, misleading, circuitous or ambiguous language that may be misconstrued or misunderstood.
- E. It is not the object of the examiner's appearance in court to present only the evidence which supports the view of the side which employs him. He has a moral obligation to see to it that the court understands the evidence as it exists and to present it in an impartial manner.
- F. The examiner will not by implication, knowingly or intentionally assist the contestants in a case through such tactics as will implant a false impression.
- G. The examiner will answer all questions put to him in a clear, straightforward manner and refuse to extend himself beyond his field of competence.
- H. Any and all photographic displays shall be made according to acceptable practices, and shall not be intentionally altered or distorted with a view to mislead the court or jury.
- I. By way of conveying information to the court, it is appropriate that any of a variety of demonstrative materials and methods be utilized by the expert witness. Such methods and materials shall not, however, be unduly sensational.
- J. In all respects the examiner will avoid the use of terms and opinions which will be assigned greater weight than are due them. Where an opinion requires qualification or explanation, it is not only proper but incumbent upon the witness to offer such qualifications.
- K. The expert should not exaggerate or embellish his qualification when testifying.

#### **IV. GENERAL PRACTICE OF FIREARM AND TOOLMARK EXAMINATION**

- A. No services shall be rendered on a contingency fee basis.
- B. It shall be regarded as ethical for one examiner to reexamine evidence material previously submitted to or examined by another. Where a difference of opinion arises, however, as to the significance of the

evidence or to the test results, it is in the interest of the profession that every effort be made by both examiners to resolve their conflict before the case goes to trial.

- C. Generally, the principle of "attorney client" relationship is considered to apply to work of a physical evidence consultant except in a situation where a miscarriage of justice might occur. Justice should be the guiding principle.
- D. It shall be ethical for an examiner to serve an attorney in an advisory capacity regarding the interrogation of another expert who may be presenting testimony. This service must be performed in good faith and not maliciously. Its purpose is to prevent incompetent testimony, but not to thwart justice.

\* - adopted 1980

- Revised Oct, 1986-preamble added and IV IID was combined with IV IIC.

- Edited Aug, 1990-missing words added to IIE and "that" corrected to "than" in IIIB.

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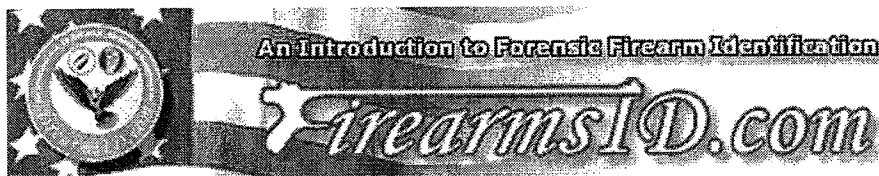
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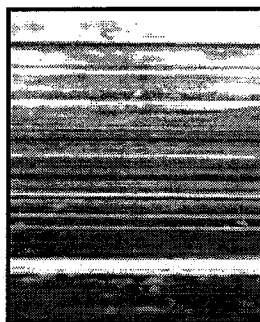
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**Bullet Identification**

**B**ullets collected for comparison to a specific firearm are examined first to see if they are of a **caliber** that could have been fired from the submitted firearm. They are then examined to determine if the pattern of **rifling impressions** found on the bullet match the pattern of **rifling** contained in the barrel of the questioned firearm. If these class characteristics agree the next step is to try to make a positive match between the individual characteristics that may have transferred to the bullet from the barrel.

Located within the rifling impressions on a bullet can be microscopic striations or scratches like those seen on the bullet below. They sort of look like a bar code don't they?



Imperfections in the surface of the interior of the barrel leave striations on the projectiles. Striations have the potential to be consistently reproduced in a unique pattern on every bullet that passes down the barrel of a firearm. The key word in the previous sentence is *unique*.

Firearm examiners will attempt to find this unique pattern by following the procedures outlined below.

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The original Magic Bullet Blender Buy online one payment \$49.99.

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Convincing through its powerful UV. Portable, 60 min battery operation.  
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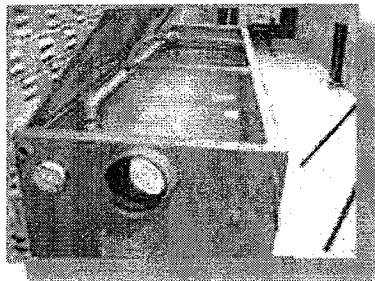
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**AFM/SPM****Microscopy**

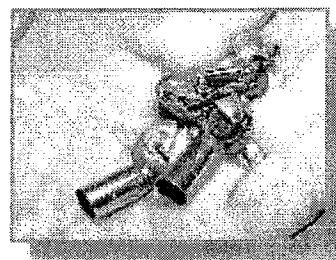
Nanoscale atomic force microscopes High resolution large samples scan  
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**Examinations conducted**

A submitted firearm will be fired several times using a water tank like the one on the left to obtain *standards* from the firearm. Lids on the tank are closed and locked and the muzzle of the firearm is placed in the open tube at the end of the tank and fired. Friction from passing through the water slows the bullets down and they end up on the bottom of the tank about halfway down its length. The tank is approximately 3 feet wide, 10 feet long and 3 feet high.

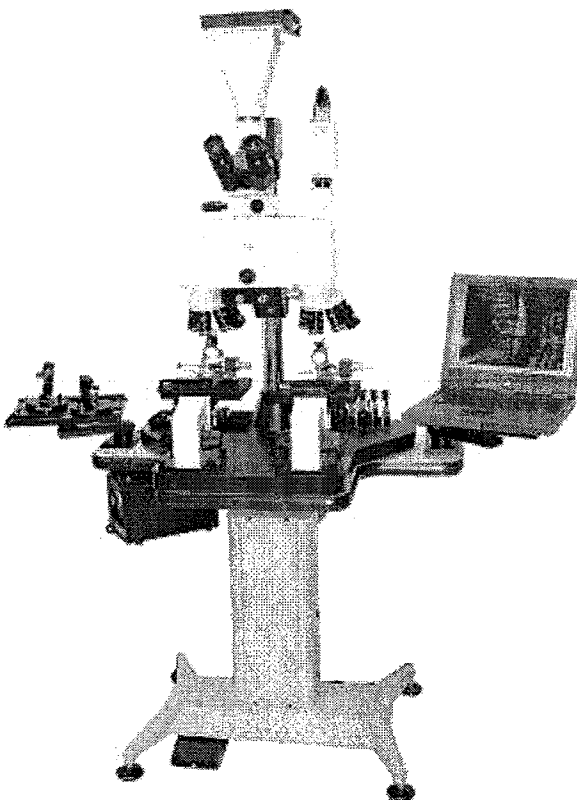


Fired standards, like those to the right, are examined first to determine if in fact the barrel is producing striated marks in a unique and consistent pattern. Once a consistently reoccurring pattern to the marks is identified on standards, the standards are compared to the evidence bullets to see if the same pattern of marks exists on the evidence. To make these comparisons the firearm examiner will use a **comparison macroscope** (below right).



Notice that this is called a **macroscope** and not a **microscope**. Microscopes typically use objectives that are 100x and above. Magnifications typically used in firearms identification are 5X, 10X, 20X, 30X, and 40X. It is not unusual however to see these lower powered scopes referred to a microscopes. In fact if you see it referred to as a microscope on this website just ignore it!

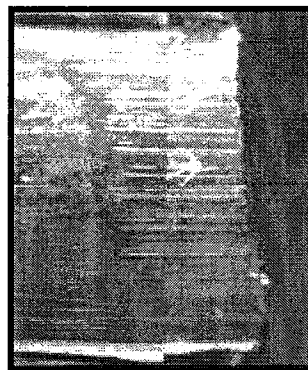
All firearm sections will have a comparison macroscope. The comparison macroscope consists of two macroscopes mounted side by side and connected by an optical bridge. There are two stages on the lower part of the macroscope that the bullets to be compared are mounted on. The bullets are attached to the stages



using some type of sticky substance. Images of the bullets travel up through the objectives, bounce off several mirrors in the optical bridge, and are combined in a round field of view seen by looking into the stereoscopic eyepieces. The resulting image will show the bullets mounted to the stages, side-by-side, with a thin dividing line down the middle. The images below show rifling impressions on a 32 caliber bullet at progressively increasing magnifications.



The stages that the bullets are attached to allow the bullets being examined to be rotated on their axis and moved up, down, to the left, and to the right. The bullets are rotated around to see if any microscopic similarities are present. Most positive identifications are made on striations that occur in land impressions and the best marks are usually near the base of the bullets like those seen below.



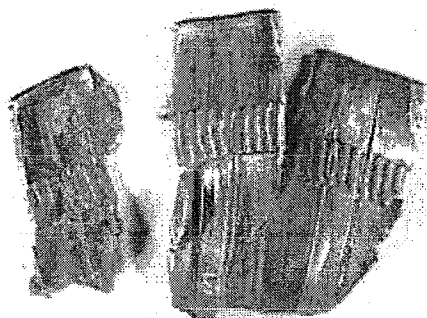
For an animated and interactive demonstration of this process see the **3-D Bullet Identification Demo**.

Not all bullet identifications are like those seen in the above image. Firearm examiners will examine the entire bullet for striations that agree with the standards. Bullets can have as many as six, eight or even twenty-two different land and groove impressions and each one may have areas of agreement between the striations. Taking an image of striations, like the one seen above will usually not be representative of the actual overall positive identification. It really



comes down to the experience of the firearm examiner and what they perceive to be the overall uniqueness of the striations that are present.

One of the biggest problems in making an identification is that few evidence bullets are submitted intact. Most are badly distorted, wiped and/or fragmented. The fragment seen below may not look like much but even small fragments and badly damaged bullets can still retain sufficient marks for an identification to be made.



Until the questioned bullet is examined microscopically by a trained firearm examiner you just don't know if it has marks of comparative value. The comparison image below shows the above bullet fragment (right) compared to a standard (left) fired from the submitted firearm.



## **Results**

When comparisons are made between firearms and fired ammunition the results can read as follows:

***Exhibit 1 (bullet) was identified as having been fired from Exhibit 2 (revolver).***

This conclusion is reached after all class characteristics agree and a sufficient correlation between individual characteristics is found.

***Exhibit 1 (bullet) could neither be identified nor eliminated as having been fired from Exhibit 2 (revolver). All comparisons were inconclusive.***

This conclusion is reached if class characteristics agree but there is an insufficient correlation between individual characteristics.

***Exhibit 1 (bullet) was not fired from Exhibit 2 (revolver).***

This conclusion is reached if class characteristics disagree.

Additional examples of bullet comparisons can be found in the ***image galleries***.

In some cases, a firearm may not be recovered for comparison. When this happens firearm examiners can examine bullets for ***general rifling characteristics (GRC)*** in an attempt to determine what brands of firearms from which the bullet may have been fired. Check the GRC links above for more information on this type of examination.

We have now discussed how bullets can be identified as having been fired from a firearm but what about the cartridge cases.

Click the ***Next*** button below to learn about ***Cartridge Case Identification***.

**Home | Top | Next**

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## ethics

### Code of Ethics (Ref: The Institute for Internal Auditors)

The purpose of the Institute's *Code of Ethics* is to promote an ethical culture in the profession of internal auditing.

A code of ethics is necessary and appropriate for the profession of internal auditing, founded as it is on the trust placed in its objective assurance about risk management, control, and governance. The Institute's *Code of Ethics* extends beyond the definition of internal auditing to include two essential components:

- Principles that are relevant to the profession and practice of internal auditing;
- Rules of Conduct that describe behaviour norms expected of internal auditors. These rules are an aid to interpreting the Principles into practical applications and are intended to guide the ethical conduct of internal auditors.

The *Code of Ethics* together with the Institute's Professional Practices Framework and other relevant Institute pronouncements provide guidance to internal auditors serving others. Internal auditors refers to Institute members, recipients of or candidates for IIA professional certifications, and those who provide internal auditing services within the definition of internal auditing.

### Applicability and Enforcement

This *Code of Ethics* applies to both individuals and entities that provide internal auditing services.

For Institute members and recipient of or candidates for IIA professional certifications, breaches of the *Code of Ethics* will be evaluated and administered according to The Institute's Bylaws and Administrative Guidelines. The fact that a particular conduct is not mentioned in the Rules of Conduct does not prevent it from being unacceptable or discreditable, and therefore, the member, certification holder, or candidate can be liable for disciplinary action.

### Principles

Internal auditors are expected to apply and uphold the following principles:

#### Integrity

The integrity of internal auditors establishes trust and thus provides the basis for reliance on their judgment.

#### Objectivity

Internal auditors exhibit the highest level of professional objectivity in gathering, evaluating, and communicating information about the activity or process being

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examined. Internal auditors make a balanced assessment of all the relevant circumstances and are not unduly influenced by their own interests or by others in forming judgments.

**Confidentiality**

Internal auditors respect the value and ownership of information they receive and do not disclose information without appropriate authority unless there is a legal or professional obligation to do so.

**Competency**

Internal auditors apply the knowledge, skills, and experience needed in the performance of internal auditing services.

**Rules of Conduct****Integrity**

Internal auditors:

- Shall perform their work with honesty, diligence, and responsibility.
- Shall observe the law and make disclosures expected by the law and the profession.
- Shall not knowingly be a party to any illegal activity, or engage in acts that are discreditable to the profession or internal auditing or to the organisation.
- Shall respect and contribute to the legitimate and ethical objectives of the organisation.

**Objectivity**

Internal auditors:

- Shall not participate in any activity or relationship that may impair or be presumed to impair their unbiased assessment. This participation includes those activities or relationships that may be in conflict with the interests of the organisation.
- Shall not accept anything that may impair or be presumed to impair their professional judgment.
- Shall disclose all material facts known to them that, if not disclosed, may distort the reporting of activities under review.

**Confidentiality**

Internal auditors:

- Shall be prudent in the use and protection of information acquired in the course of their duties.
- Shall not use information for any personal gain or in any manner that would be contrary to the law or detrimental to the legitimate and ethical objectives of the organisation.

**Competency**

Internal auditors:

- Shall engage only in those services for which they have the necessary knowledge, skills, and experiences.
- Shall perform internal auditing services in accordance with the *Standards for the Professional Practice of Internal Auditing*.
- Shall continually improve their proficiency and the effectiveness and quality of their services.

Free Management Library | Free Management Library Topic Search | Free Management Library Topic Search | General Guidelines for Conducting Interviews

## General Guidelines for Conducting Interviews

Written by Carter McNamara, MBA, PhD, Authenticity Consulting, LLC. Copyright 1997-2007.

Adapted from the Field Guide to Consulting and Organizational Development.

### Sections of This Topic Include:

Introduction  
Preparation for Interview  
Types of Interviews  
Types of Topics in Questions  
Sequence of Questions  
Wording of Questions  
Carrying Out Interview  
Immediately After Interview  
Other Resources

---

### Introduction

Interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around a topic. Interviews may be useful as follow-up to certain respondents to questionnaires, e.g., to further investigate their responses. Usually open-ended questions are asked during interviews.

Before you start to design your interview questions and process, clearly articulate to yourself what problem or need is to be addressed using the information to be gathered by the interviews. This helps you keep clear focus on the intent of each question.

### Preparation for Interview

1. Choose a setting with little distraction. Avoid loud lights or noises, ensure the interviewee is comfortable (you might ask them if they are), etc. Often, they may feel more comfortable at their own places of work or homes.
2. Explain the purpose of the interview.
3. Address terms of confidentiality. Note any terms of confidentiality. (Be careful here. Rarely can you absolutely promise anything. Courts may get access to information, in certain circumstances.) Explain who will get access to their answers and how their answers will be analyzed. If their

comments are to be used as quotes, get their written permission to do so. See getting informed consent.

4. Explain the format of the interview. Explain the type of interview you are conducting and its nature. If you want them to ask questions, specify if they're to do so as they have them or wait until the end of the interview.
5. Indicate how long the interview usually takes.
6. Tell them how to get in touch with you later if they want to.
7. Ask them if they have any questions before you both get started with the interview.
8. Don't count on your memory to recall their answers. Ask for permission to record the interview or bring along someone to take notes.

## Types of Interviews

1. Informal, conversational interview - no predetermined questions are asked, in order to remain as open and adaptable as possible to the interviewee's nature and priorities; during the interview, the interviewer "goes with the flow".
2. General interview guide approach - the guide approach is intended to ensure that the same general areas of information are collected from each interviewee; this provides more focus than the conversational approach, but still allows a degree of freedom and adaptability in getting information from the interviewee./LI>
3. Standardized, open-ended interview - here, the same open-ended questions are asked to all interviewees (an open-ended question is where respondents are free to choose how to answer the question, i.e., they don't select "yes" or "no" or provide a numeric rating, etc.); this approach facilitates faster interviews that can be more easily analyzed and compared.
4. Closed, fixed-response interview - where all interviewees are asked the same questions and asked to choose answers from among the same set of alternatives. This format is useful for those not practiced in interviewing.

## Types of Topics in Questions

Patton notes six kinds of questions. One can ask questions about:

1. Behaviors - about what a person has done or is doing
2. Opinions/values - about what a person thinks about a topic
3. Feelings - note that respondents sometimes respond with "I think ..." so be careful to note that you're looking for feelings
4. Knowledge - to get facts about a topic

5. **Sensory** - about what people have seen, touched, heard, tasted or smelled
6. **Background/demographics** - standard background questions, such as age, education, etc.

Note that the above questions can be asked in terms of past, present or future.

## **Sequence of Questions**

1. Get the respondents involved in the interview as soon as possible.
2. Before asking about controversial matters (such as feelings and conclusions), first ask about some facts. With this approach, respondents can more easily engage in the interview before warming up to more personal matters.
3. Intersperse fact-based questions throughout the interview to avoid long lists of fact-based questions, which tends to leave respondents disengaged.
4. Ask questions about the present before questions about the past or future. It's usually easier for them to talk about the present and then work into the past or future.
5. The last questions might be to allow respondents to provide any other information they prefer to add and their impressions of the interview.

## **Wording of Questions**

1. Wording should be open-ended. Respondents should be able to choose their own terms when answering questions.
2. Questions should be as neutral as possible. Avoid wording that might influence answers, e.g., evocative, judgmental wording.
3. Questions should be asked one at a time.
4. Questions should be worded clearly. This includes knowing any terms particular to the program or the respondents' culture.
5. Be careful asking "why" questions. This type of question infers a cause-effect relationship that may not truly exist. These questions may also cause respondents to feel defensive, e.g., that they have to justify their response, which may inhibit their responses to this and future questions.

## **Conducting Interview**

1. Occasionally verify the tape recorder (if used) is working.
2. Ask one question at a time.



3. Attempt to remain as neutral as possible. That is, don't show strong emotional reactions to their responses. Patton suggests to act as if "you've heard it all before."
4. Encourage responses with occasional nods of the head, "uh huh"s, etc.
5. Be careful about the appearance when note taking. That is, if you jump to take a note, it may appear as if you're surprised or very pleased about an answer, which may influence answers to future questions.
6. Provide transition between major topics, e.g., "we've been talking about (some topic) and now I'd like to move on to (another topic)."
7. Don't lose control of the interview. This can occur when respondents stray to another topic, take so long to answer a question that times begins to run out, or even begin asking questions to the interviewer.

## **Immediately After Interview**

1. Verify if the tape recorder, if used, worked throughout the interview.
2. Make any notes on your written notes, e.g., to clarify any scratchings, ensure pages are numbered, fill out any notes that don't make senses, etc.
3. Write down any observations made during the interview. For example, where did the interview occur and when, was the respondent particularly nervous at any time? Were there any surprises during the interview? Did the tape recorder break?

## **Other Resources**

CASAnet's overview of interviewing principles



## **For the Category of Evaluations (Many Kinds):**

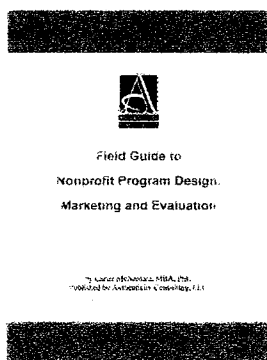
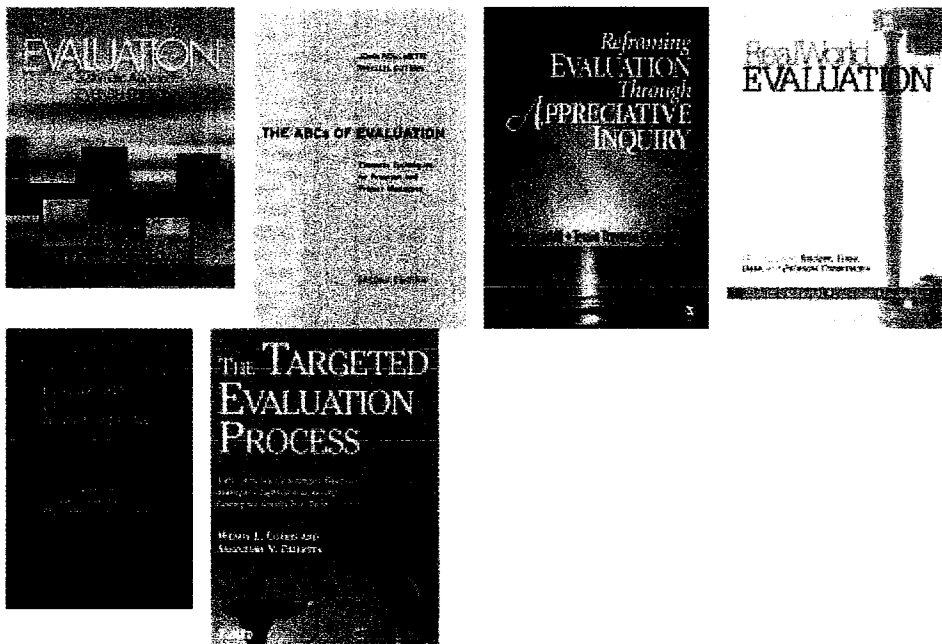
### **Related Library Topics**

### **Recommended Books**

### **General Information (Applying to Many Types Evaluation)**

The following books are recommended because of their highly practical nature and often because they include a wide range of information about

this Library topic. To get more information about each book, just hover your cursor over the image of the book. A "bubble" of information will be displayed. You can click on the title of the book in that bubble to get more information, too.



**Field Guide to Nonprofit Program Design, Marketing and Evaluation**  
by Carter McNamara, published by Authenticity Consulting, LLC. There are few books, if any, that explain how to carefully plan, organize, develop and evaluate a nonprofit program. Also, too many books completely separate the highly integrated activities of planning, marketing and evaluating programs. This book integrates all three into a comprehensive, straightforward approach that anyone can follow in order to provide high-quality programs with strong appeal to funders. Includes many online forms that can be downloaded. Many materials in this Library topic are adapted from this book.

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## Also see

***For evaluating employees, Supervision -- Recommended Books***

***For evaluating nonprofit programs, Program Management -- Recommended Books***





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## Police forensics has extensive backlog

Police forensic science laboratories (FSLs) have a backlog of 6 086 samples, Safety and Security Minister Charles Ngakula said on Monday.

Crime investigating officers have to wait an average of 54 days for results of samples sent in.

In written reply to a question by the Democratic Alliance's Dianne Kohler-Barnard, he said the largest backlog was in the Western Cape's chemistry laboratory, where 3 806 samples were awaiting processing on June 4.

The SA Police Service (SAPS) headquarters' chemistry lab had a backlog of 1 057 samples, SAPS' headquarters biology laboratory 560, and the Western Cape biology laboratory 482.

There were no backlogs at all in any of the explosives and ballistics laboratories around the country.

Investigating officers could expect to wait an average of 102 days for the results from the biology laboratories, 56 days from chemistry, 40 from ballistics, and 35 days for questioned documents or scientific analysis.

The laboratories had 981 funded posts and only 15 vacancies as at May 31.

Ngakula said the funded posts for the Medium Term Expenditure Framework up until 2010 for the FSLs were currently under consideration and indications were that a substantial growth in the number of posts could be expected.

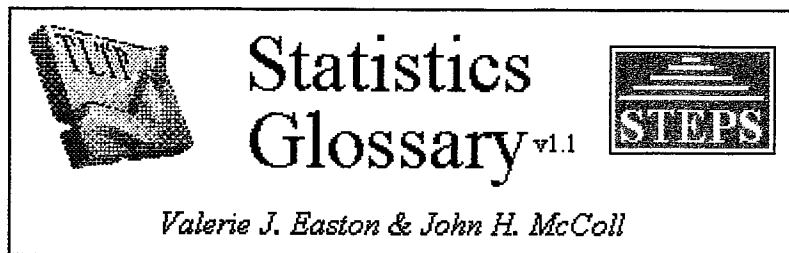
Commenting on the situation on Monday, Kohler-Barnard said the high number of samples in the backlog as well as the long waiting periods were a cause for concern.

"It is hoped that the drive to recruit new personnel will improve matters," she said. - Sapa

*Published on the Web by IOL on 2007-06-18 18:11:23*

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## Sampling

**Target Population**

**Quota Sampling**

**Matched Samples**

**Spatial Sampling**

**Independent Samples**

**Sampling Variability**

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**Standard Error**

**Simple Random Sampling**

**Bias**

**Stratified Sampling**

**Precision**

**Cluster Sampling**

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### **Target Population**

The target population is the entire group a researcher is interested in; the group about which the researcher wishes to draw conclusions.

#### *Example*

Suppose we take a group of men aged 35-40 who have suffered an initial heart attack. The purpose of this study could be to compare the effectiveness of two drug regimes for delaying or preventing further attacks. The target population here would be all men meeting the same general conditions as those actually included in the study.



## Matched Samples

Matched samples can arise in the following situations:

- a. Two samples in which the members are clearly paired, or are matched explicitly by the researcher. For example, IQ measurements on pairs of identical twins.
- b. Those samples in which the same attribute, or variable, is measured twice on each subject, under different circumstances. Commonly called repeated measures. Examples include the times of a group of athletes for 1500m before and after a week of special training; or the milk yields of cows before and after being fed a particular diet.

Sometimes, the difference in the value of the measurement of interest for each matched pair is calculated, for example, the difference between before and after measurements, and these figures then form a single sample for an appropriate statistical analysis.



## Independent Sampling

Independent samples are those samples selected from the same population, or different populations, which have no effect on one another. That is, no correlation exists between the samples.



## Random Sampling

Random sampling is a sampling technique where we select a group of subjects (a sample) for study from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has a known, but possibly non-equal, chance of being included in the sample.

By using random sampling, the likelihood of bias is reduced.

Compare simple random sampling.



## Simple Random Sampling

Simple random sampling is the basic sampling technique where we select a group of subjects (a sample) for study from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has an equal chance of being included in the sample. Every possible sample of a given size has the same chance of selection; i.e. each member of the population is equally likely to be chosen at any stage in the sampling process.

Compare random sampling.



### **Stratified Sampling**

There may often be factors which divide up the population into sub-populations (groups / strata) and we may expect the measurement of interest to vary among the different sub-populations. This has to be accounted for when we select a sample from the population in order that we obtain a sample that is representative of the population. This is achieved by stratified sampling.

A stratified sample is obtained by taking samples from each stratum or sub-group of a population.

When we sample a population with several strata, we generally require that the proportion of each stratum in the sample should be the same as in the population.

Stratified sampling techniques are generally used when the population is heterogeneous, or dissimilar, where certain homogeneous, or similar, sub-populations can be isolated (strata). Simple random sampling is most appropriate when the entire population from which the sample is taken is homogeneous. Some reasons for using stratified sampling over simple random sampling are:

- a. the cost per observation in the survey may be reduced;
- b. estimates of the population parameters may be wanted for each sub-population;
- c. increased accuracy at given cost.

#### *Example*

Suppose a farmer wishes to work out the average milk yield of each cow type in his herd which consists of Ayrshire, Friesian, Galloway and Jersey cows. He could divide up his herd into the four sub-groups and take samples from these.



### **Cluster Sampling**

Cluster sampling is a sampling technique where the entire population is divided into groups, or clusters, and a random sample of these clusters are selected. All observations in the selected clusters are included in the sample.

Cluster sampling is typically used when the researcher cannot get a complete list of the members of a population they wish to study but can get a complete list of groups or 'clusters' of the population. It is also used when a random sample would produce a list of subjects so widely scattered that surveying them would prove to be far too expensive, for example, people who live in different postal districts in the UK.

This sampling technique may well be more practical and/or economical than simple random sampling or stratified sampling.

#### *Example*

Suppose that the Department of Agriculture wishes to investigate the use of pesticides by farmers in England. A cluster sample could be taken by identifying the different counties in England as clusters. A sample of these counties (clusters) would then be chosen at random, so all farmers in those counties selected would be included in the sample. It can be seen here then that it is easier to visit several farmers in the same county than it is to travel to each farm in a random sample to observe the use of pesticides.



### **Quota Sampling**

Quota sampling is a method of sampling widely used in opinion polling and market research. Interviewers are each given a quota of subjects of specified type to attempt to recruit for example, an interviewer might be told to go out and select 20 adult men and 20 adult women, 10 teenage girls and 10 teenage boys so that they could interview them about their television viewing.

It suffers from a number of methodological flaws, the most basic of which is that the sample is not a random sample and therefore the sampling distributions of any statistics are unknown.



### **Spatial Sampling**

This is an area of survey sampling concerned with sampling in two (or more) dimensions. For example, sampling of fields or other planar areas.





## Sampling Variability

Sampling variability refers to the different values which a given function of the data takes when it is computed for two or more samples drawn from the same population.



## Standard Error

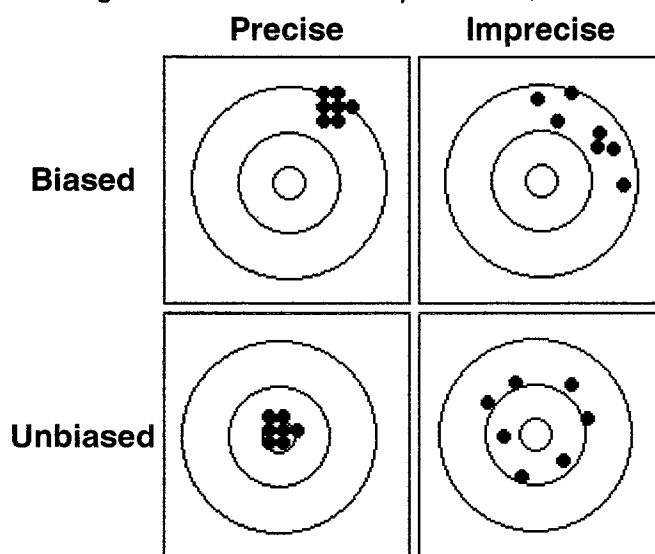
Standard error is the standard deviation of the values of a given function of the data (parameter), over all possible samples of the same size.



## Bias

Bias is a term which refers to how far the average statistic lies from the parameter it is estimating, that is, the error which arises when estimating a quantity. Errors from chance will cancel each other out in the long run, those from bias will not.

The following illustrates bias and precision, where the target value is the bullseye:



### Example

The police decide to estimate the average speed of drivers using the fast lane of the motorway and consider how it can be done. One method suggested is to tail cars using police patrol cars and record their speeds as being the same as that of the police car. This is likely to produce a biased result as any driver exceeding the speed limit will slow down on seeing a police car behind them. The police then decide to use an unmarked car for their investigation using a speed gun operated by a constable. This is an unbiased method of measuring speed, but is imprecise compared to using

a calibrated speedometer to take the measurement.

See also [precision](#).



## Precision

Precision is a measure of how close an estimator is expected to be to the true value of a parameter.

Precision is usually expressed in terms of imprecision and related to the standard error of the estimator. Less precision is reflected by a larger standard error.

See the illustration and example under [bias](#) for an explanation of what is meant by bias and precision.

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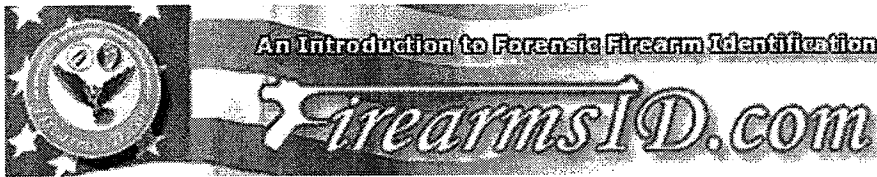
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**Shotgun Pattern Testing**

**A**nother test conducted by firearm examiners is known as **Shotgun Pattern Testing**. This test involves shotguns and allows for a muzzle-to-target distance to be determined.

Shotgun pattern testing involves examining evidence for a pattern of holes created by the pellets fired from a shotgun. The "unknown" pattern is then compared to "test" patterns created with the suspect shotgun fired at known distances. This will allow for an approximate muzzle-to-target distance to be determined.



**Two overlapping shot patterns. A large dispersed pattern overlaps a small close-range shot pattern.**

When a shotgun is fired using a multiple pellet shotshell, the pellets exit the barrel of the shotgun and begin to spread out into a pattern that increases in diameter as the distance increases between the pellets and the shotgun.

To better understand the principles involved in shotgun pattern testing it's important to first learn a little about shotguns and the shotshells they fire.

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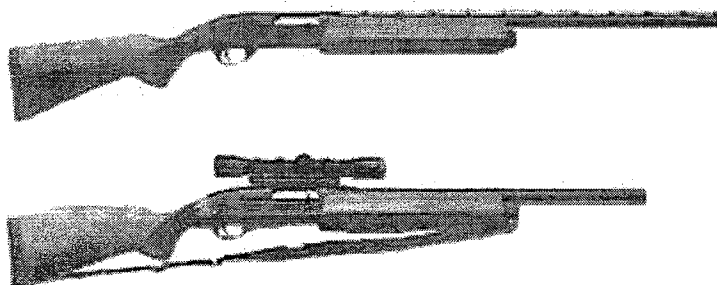
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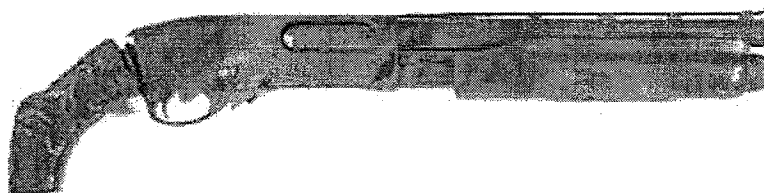
**Shotguns** are firearms typically fired from the shoulder that are designed to fire shotshells containing anywhere from one large projectile to as many as several hundred small pellets. Shotguns aren't classified by caliber but come in different **gauges**. *The gauge of a shotgun is determined by the number of round lead balls of bore diameter that it takes to equal one pound.* Shotguns can come in 10, 12, 16, 20, 28, and .410 gauge. The .410 is actually an exception with .410 referring to the caliber of the shotgun's bore. It would actually be about a 67 gauge in "lead ball" terms.

Although some newer shotgun barrels are produced with rifling, shotguns have traditionally had smooth bored barrels. Except in some rare cases the projectiles fired from them cannot be matched back to the shotgun.



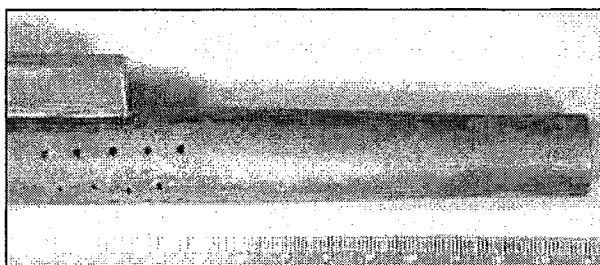
**Auto loading shotgun with conventional barrel (top) and an auto loading shotgun with a rifled "slug" barrel (bottom).**

Shotguns come in a number of different styles and actions. From auto loading shotguns like those seen above to very "customized" versions like the one below.



**"Sawed-off" pump-action shotgun.**

Shotguns are typically manufactured with what is called a **choke** in their barrels. A choke is a constriction in the last couple of inches in the barrel and can vary in the degree of constriction. Common choke designations are "full", "modified", and "improved cylinder." A barrel that has no choke is referred to as a cylinder-bore barrel.



**Barrel modified for use in a "Turkey-Shoot" competition.  
Extreme constriction or choke can be seen at the muzzle.**

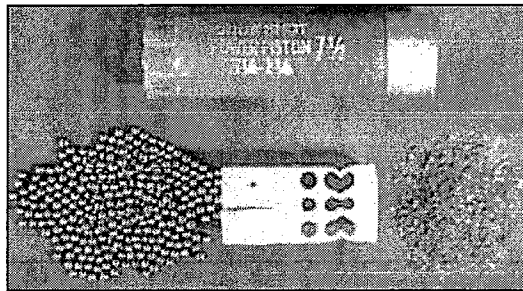
Shotguns can be manufactured with a permanent fixed choke or can have the muzzle of the barrel machined in a way to accept interchangeable or adjustable choke tubes. Shotguns that have had their barrels sawed off have had their choke removed. This creates a shotgun with a cylinder-bore barrel.

The whole point to this "choke thing" is that the choke plays an important role in the rate at which the shot pellets spread as they travel away from the shotgun. A full-choke barrel will tend to shoot smaller shot patterns at a given distance than a barrel with a modified-choke.

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**Shotshells** are cartridges designed to be fired in shotguns and can contain a single large projectile - a slug - or as many as several hundred small spherical pellets called **shot**. Shot used in shotshells has traditionally been made of lead but because of its toxicity, other materials are being used as a substitute, with the most common alternative being steel.

The size of the shot can vary as can the total weight of the shot loaded into a shotshell. Shot comes in two basic varieties, small pellets commonly referred to as **birdshot** and larger pellets called **buckshot**.



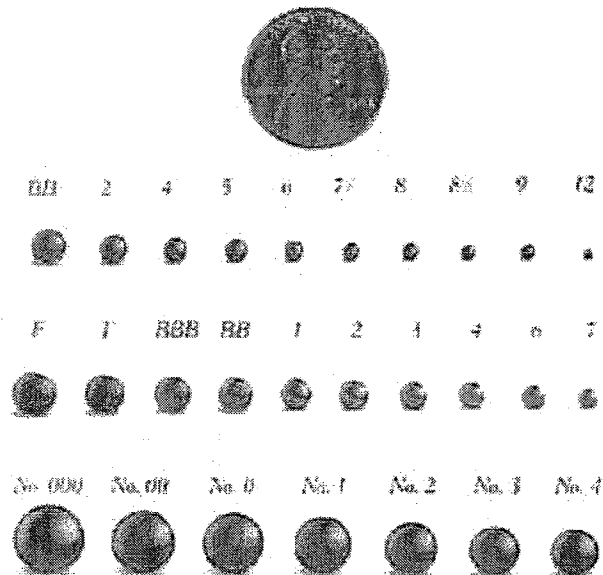
**Components from a typical shotshell containing birdshot and a one-piece plastic wad.**



**Components from a typical shotshell containing buckshot and a fiber/plastic wad combination.**

Lead birdshot comes in 12, 11, 9, 8 1/2, 8, 7 1/2, 6, 5, 4, 2, and BB sizes. As the numbers get smaller the diameter of the shot gets

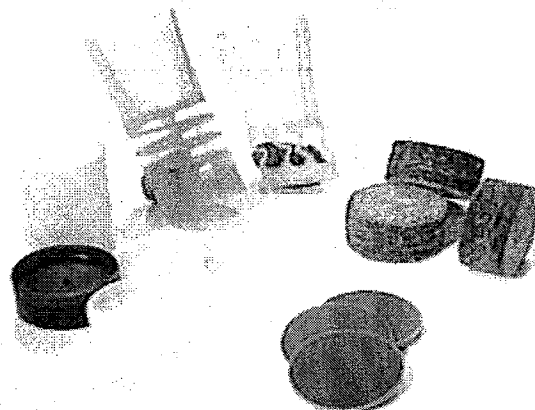
larger. Buckshot on the other hand comes in 4, 3, 2, 1, 0, 00, and 000. Again, as the number decreases the diameter increases. See the chart below.



**Shot size table: lead shot (top), steel shot (middle) and buckshot (bottom).**

As you can see from the above chart, steel shot comes in slightly larger sizes than lead shot. Steel doesn't have the density of lead and larger shot is needed to achieve a range comparable to that of lead shot.

Shotshells contain a variety of different **wads** - plastic, paper, or fiber material designed to separate the shot from the gunpowder and/or protect the shot as it is pushed down the barrel - that are expelled from the shotshell, along with the shot, when fired.



**Various plastic and fiber shotshell wads.**

Shotshells come in a variety of loads. The amount of gunpowder in a shotshell can vary and the measurement is referred to by as the **dram equivalent**. The dram equivalent is the amount of smokeless powder that produces a velocity comparable to that of

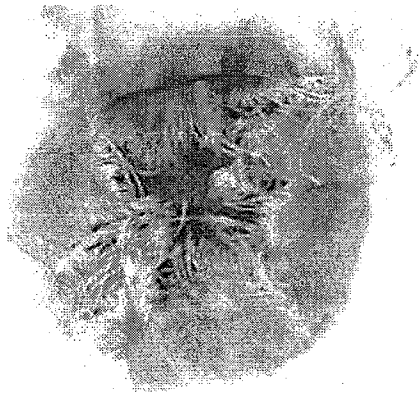
black powder.

All of these variables are important in determining a given shot pattern distance.

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When a shotgun is fired the shot and wadding travel down the barrel and exit the muzzle in a concentrated mass.

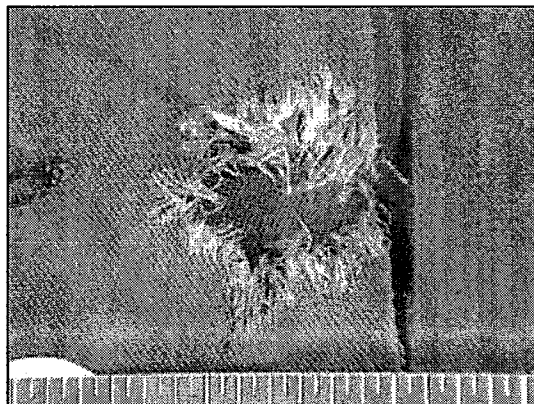
As a result a contact entrance hole will produce a large hole with significant damage to the margins of the hole, but can vary greatly depending on the material being fired into. The same thing also applies to gunshot residue deposits. Most contact entrance holes will have a significant deposit of gunshot residues like the one seen below, but this is not always the case. Some may display very little visible gunshot residue.



**Contact shotgun entrance hole.**

A hole like the one above will be processed chemically like that previously described on the Distance Determination/Gunshot Residue pages.

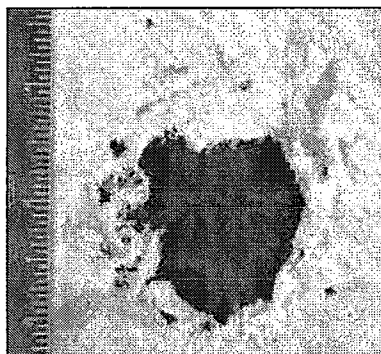
At ranges of around 5-10 feet\* the shot and wadding mass will produce a single large hole in a target. If the target happens to be a person, the wadding material will be blown into the wound tract with the pellets.



**Close-range shotshell pellet entrance hole.**

The close-range entrance (less than 5 feet\*)hole seen above is almost square, and is a common shape for this range. You might notice a pinkish color (lead residue) to the material around the hole.

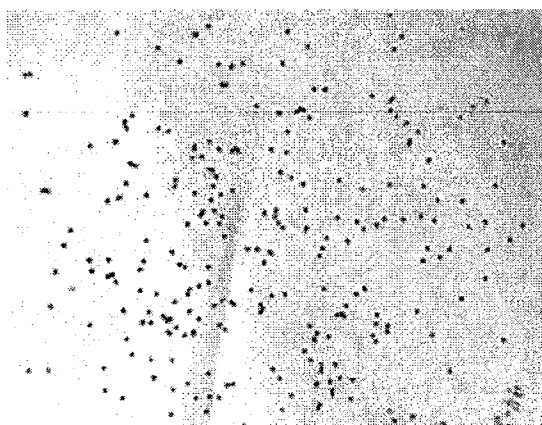
At distances greater than 5-10 feet\* the shot mass starts to break up. Fliers (individual pellet holes) will start to appear around the edge of an entrance hole and the wadding may or may not enter the victim.



**Individual pellets starting to break apart from the main mass of pellets.**

As the wadding slows down it will start to take a separate trajectory from that of the shot and can actually leave abrasions or bruises to the area around an entrance wound. Wadding will lose its energy and fall harmlessly to the ground at distances of around 20 feet\*.

As the pellets get further and further away from the shotgun the pattern will eventually become dispersed to the point that only individual pellet holes are present in a target.



**Witness panel fired into at a distance of 28 feet.**

Firearm examiners will try to reproduce the pattern by firing into witness panels at known distances. Shot patterns can be affected by the load, pellet size, wad type, and choke of the shotgun. That is why it is essential that the shotgun is recovered and the type of shotshells used is known. Hopefully some shotshells will be



recovered at the scene that can later be used in firing the distance standards. Also, patterns produced by a shotgun at any given distance can vary slightly. Multiple tests patterns will be fired at known distances and compared directly to the pattern in question. Based on this comparison a minimum and maximum firing distance can be determined.

Unlike the tests conducted on clothing for gunshot residues, shotgun pattern testing is not limited to distances of a few feet or less.

**\*All distances are approximate values and can vary depending on the shotgun's gauge/choke and ammunition used.**

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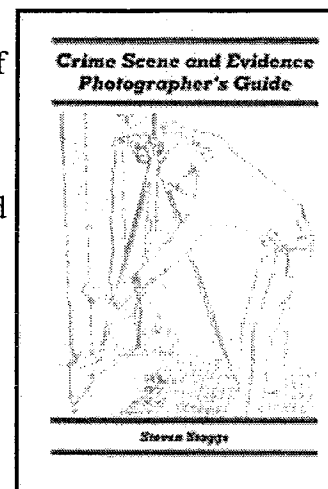
# Crime Scene and Evidence Photographer's Guide

ISBN 0-9661970-0-3  
Published 1997

by Steven Staggs

From documenting a homicide scene to recording the detail of a bite mark, photographs can communicate more about crime scenes and the appearance of evidence than the written report. Photography is a valuable tool for recording the crime scene and explaining evidence to others.

The *Crime Scene and Evidence Photographer's Guide* is designed to be a field reference for those responsible for photography at the crime scene. It may be used by law enforcement officers, investigators, and crime scene technicians. It contains instructions for photographing a variety of crime scenes and various types of evidence. It is a valuable reference tool when combined with training and experience. The *Crime Scene and Evidence Photographer's Guide* is also a helpful resource for students and others interested in entering into the field of crime scene investigation.



The *Crime Scene and Evidence Photographer's Guide* is a practical and concise field handbook for crime scene and evidence photography. Designed to be carried in an evidence kit or camera bag, this 66 page, 5 ½" by 8 ½" publication contains step-by-step instructions for photographing crime scenes and evidence. It includes 42 example photographs, eight diagrams, and three tables. Sections in the guide include:

## Cameras and Lighting Techniques

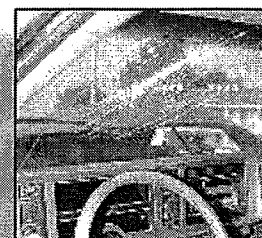
- Technical photography techniques
- Flash illumination
- Flash fill
- Painting with light
- Available light photography

## Photographing Crime Scenes

- The three step approach
  - Overview photographs
  - Mid-range photographs
  - Close-up photographs
- Using video to record crime scenes
- Records of photographs

## Photographing Specific Types of Crime Scenes

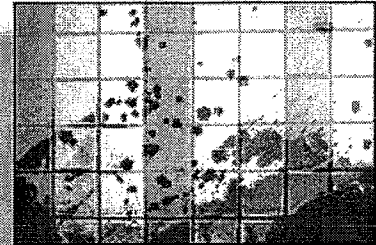
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### Photographing Evidence

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- Lighting methods for close up photography
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### About the Author

Steven Staggs has been in law enforcement for 30 years and has extensive experience in crime scene photography and identification. He has testified in superior court concerning his crime scene, evidence, and autopsy photography and has handled high profile cases including a nationally publicized serial homicide case.

For the past 18 years Steve has been a forensic photography instructor and has trained more than 3,000 crime scene technicians and investigators for police and sheriffs departments, district attorneys offices, and federal agencies. He is also a guest speaker for investigators' associations and provides consulting to law enforcement agencies.



Steve was prompted to write the *Crime Scene and Evidence Photographer's Guide* in response to requests by crime scene investigators and forensic photographers who desired a practical and concise field handbook for crime scene and evidence photography.

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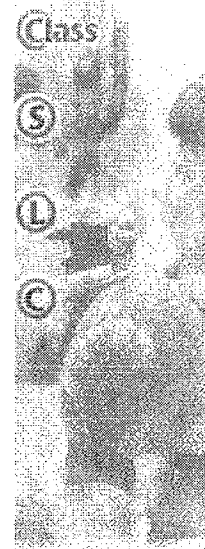
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# Lesson: Research Sampling

- ✚ Welcome to the course
- ✚ Requirements Getting Started
- ✚ Help



Sampling: is a process used to study a response to an intervention in a small population that can be applied to a larger population. Some terms to become familiar with are listed and explained below.

## 1. Element:

An element is the most basic unit on which information will be collected - individuals, chart records, etc.. For example: In a study of nursing delivery system in hospital that has three different units using 3 different delivery systems, the elements are the first floor case method, the second floor team method, and the third floor partnership model

## 2. Population

A population is a set of individuals that meet sampling criteria

The target population is the entire set of population that the researcher would like to make generalizations about

The accessible population is the one that meets the criteria established and is also accessible, considering constraints of time, money, researcher availability

## 3. Generalizability

Generalizability is extending findings from the sample to the larger population

## 4. Sampling Criteria

A well defined set that meets very specific criteria

1. criteria must be very well defined
2. must have limiting factors so that persons not meeting the criteria will be excluded
3. must be able to control for homogeneity by excluding from the desired population anyone who would bring in a confounding variable

## 5. Representativeness

The extent to which the sample and the population are alike

## 6. Sampling Unit

The selection of a portion of the target population that will represent the entire population

### Types of Sampling

#### NONPROBABILITY SAMPLING

Uses a non random method to select the sample - you cannot be assured that every element available is fairly represented in the sample

##### 1. CONVENIENCE SAMPLING

Uses the most readily available subjects and is the easy method to obtain subjects

Example: all students enrolled in a nursing program; first 200 patients admitted to a nursing unit

Problem: risk of bias is very great  
sample tends to be self selecting:  
what motivated people to volunteer?  
what sample of the population is missed because they were not available?

##### 2. QUOTA SAMPLING

Knowledge about the population is used to build some design into the sample

Each stratum of the population is represented proportionally

Must base sampling on previous knowledge: from a literature review

Example: you want to study attitudes of nurses about use of nursing diagnosis what type of samples would you think would be important to include? level of education ; years in practice as a nurse

Problem: Even these techniques do not assure that no bias may be present  
- in the above example, what variable could affect a nurse's willingness to participate in the study?

##### 3. PURPOSIVE SAMPLING

Researcher handpicks subjects to participate in the study based on identified variables under consideration. Used when the population for study is highly unique

Example: Parents of children with Tay Sach's disease

Problems: Must assume that errors of judgment in ranges of the sample will tend to even out - as many subjects who are at the far ends of the population will cancel each other out

### Uses for purposive sampling

1. validation of a test or instrument with a known population
2. collection of exploratory data from an unusual population
3. use in qualitative studies to study the lived experience of a specific population

How does purposive and quota sampling differ?

Purposive restrict the sample population to a very specific population and then tends to use all of the subjects available

### PROBABILITY TESTING

Random selection of subjects from a specific population

### SIMPLE RANDOM SAMPLING

population if defined listing all of the descriptors identify all populations that meet the descriptors and give each a number use a table of random numbers to select population for study, read off numbers in any fixed direction

Advantages: researcher bias cannot operate representation of the desired population is maximized probability of selecting a nonrepresentative sample is decreased as the sample size is increased

Disadvantages: very time consuming  
it may be impossible to obtain a list of every person eligible to be part of the population under study

### 1. STRATIFIED RANDOM SAMPLING

uses a quota for subsets to ensure that all subgroups are fairly represented similar to proportional quota sampling except that a random approach is used to select the sub populations

Example: see diagram of study on registered nurses

Questions to be addressed

1. what is the logical basis for selecting the subsets?
2. do you have sufficient information available to divide population into subsets
3. should each subset be equal in size or should the size be based on the frequency in the population?
4. are there enough subjects to get meaningful groups into each subset?

5. have random procedures ben used to select subjects for each of the subsets?

Problems: similar to a simple random design in terms of stability to identify appropriate subjects

greater because of the need for greater numbers of subjects to fill each of the subsets

## 2. CLUSTER SAMPLING

used to break up large groups into smaller workable models

Example: The researcher wants to examine nursing practices in county health departments

Stage 1: identify all states - each will be a sampling group - randomly select a certain percentage of states

Stage 2: select a random sample of subjects from the first sample: a random sample of county health departments within the states selected

Stratified random sampling technique could be used by looking at counties based on rural vs urban, etc.

Advantages: more economical of time and money

Disadvantage: sampling error can creep in

## 3. SYSTEMATIC SAMPLING

select every nth subject from a list of all possible subjects - example: every 5th patient admitted to the hospital

the population listing must be random - example a list of nurses by alphabetical order

the sample selection of the population must start at a random point - if you had an alphabetical listing of all subjects, you would not start with the "A" - but rather with a random point in the list and then go by the nth interval

Sampling interval - determined by the size of the group

$n = \frac{\text{total population}}{\text{size of the desired sample}}$

Problems: be sure geographic or cyclic events are not introduced

Example: use of 7 as an interval size when looking at use of a facility

Geographic regions that happen to vary with the interval size: every 3rd room being a private room as compared to double rooms



#### 4. MATCHED SAMPLING

used to obtain equivalent comparison groups: match on characteristics such as age, sex, schooling, etc.

#### SAMPLE SIZE

##### Power Analysis

In quantitative studies, the larger the sample the greater likelihood will it be non biased

In qualitative studies, the sample size is generally very small

The sample size will be indicated by the type of statistical tools that will be used

The degree of precision needed will help to determine sample size

The smaller the expected differences in subject response to the intervention, the large the sample size needed to demonstrate a significantly different response

If the study has been well designed, a smaller sample size can produce good results

Once you have read this lesson, you should go to [Assignment 1](#).

Want to talk to your classmates? [Go to the Student Union!](#)

E-mail Ilene Decker at [mezza@jan.ucc.nau.edu](mailto:mezza@jan.ucc.nau.edu)

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## Interview schedule

### **Topic:**

Time dependant effects of human blood on the microscopic comparison of fired bullets

*Respondent* \_\_\_\_\_

### Instructions

1. Participation in this study is voluntary.
2. Please answer all the questions.
3. It should take approximately take an hour to complete this interview.
4. Interviewees will not be identified individually, and all information will be treated as confidential.

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1 Background of respondent

1.1 Years of experience in the field of Firearms and Toolmarks examination?

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1.2 What is your current position?

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1.3 Please list your current duties that you perform within the laboratory?\

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1.4 The name and location of the laboratory?

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1.5 If you work for an accredited laboratory please list the association under which your laboratory is accredited?

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1.6 What training did you receive to become a qualified scientist?

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2. **Does human blood affect the bullet to the point where striation marks become unidentifiable?**

2.1 How many crime scenes and or autopsies do your section attend annually?

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2.2 How many crime scenes did you attend in the last year? *(For the purpose of this study crime scenes include attending autopsies and the examination of vehicles)*

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2.3 How many firearms related cases did you independently examined?

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2.4 In your opinion, list two elements that contribute to bullet damage found on crime scenes?

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2.5 Can a bullets condition deteriorate over time on a crime scene? Justify your response.

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2.6 Would you handle bullets differently if it were covered in blood? Why?

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2.7 Besides bullets what other factors can contribute to bullet corrosion?

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2.8 Does trace evidence play a role on bullet deterioration? Please explain.

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2.9 Do your section have a procedure that specifically deals with the handled of bullets on crime scenes?

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2.10 How do you go about assessing whether or not a bullet is of value for microscopic examination?

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2.11 Did you ever examine bullets covered in blood?

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2.12 Did blood play a role in the deterioration of striation marks?

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2.13 What were your findings?

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**3. Collect and packaging of bullets?**

3.1 How are bullets collected from crime scenes and autopsies?

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3.2 How are the collect of bullets documented?

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3.3 If the victim is still alive how are bullets collected?

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3.4 Is there a designated time period in which bullets must be submitted to crime scenes?

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3.5 What is the protocol for packaging bullets exposed to blood?

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3.6 As an examiner do you always receive bullets packaged in the same way?

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3.7 How do you suggest bullets should be packaged?

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3.8 Will the way in which you package bullets have a impact on the condition of the bullet?

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3.9 Does time play a role from the time bullets are collected until its examined by the examiner?

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3.10 Should bullets be cleaned that's covered in trace evidence such as blood?

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3.11 What procedure is followed if blood on the bullets are required for DNA analyst?

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3.12 How soon after a bullet is collected from the crime scene is it submitted to the Laboratory? *[This can be an estimate based on the current workload that you have]*

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3.13 What submission guidelines are available to clients for collecting and packaging projectiles? *[List the guidelines relevant to projectiles]*

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**4. How long does it take from the time when bullets are collected on the crime scene to the actual time when bullet is examined by an examiner?**

4.1 Who is responsible for collecting bullets from crime scenes?

4.2 Is timelines provided on bullet submissions to the laboratory?

4.3 How many cases do you currently have on hand?

4.4 What cases do you prioritize?

4.5 How long will a case be with you before starting the examination?

4.6 Have other disciplines impacted your turn around time in the examination of bullets?

4.7 If yes,

4.7.1 What discipline?

4.7.2 What was the purpose of their examination?

4.7.3 How long did you wait for the evidence to be transferred to the Firearms section?

4.8 Was the bullet exposed to blood?

- 4.9 What was the condition of the bullet before being clean? (any value for microscopic examination)
- 4.10 Was the bullet cleaned with any chemical reagent?
- 4.11 Please list the microscopic results?
- 4.12 In your opinion did your microscopic results change due to the bullets being exposed to blood?

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Scientific process for the microscopic examination of fired bullets.

- 5.1 What types of examinations are conducted on fired bullets?

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- 5.2 How is the examination of fired bullets documented?

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- 5.3 What instrumentation is used for the microscopic examination of fired bullets?

5.4 Is the examination you conduct a subjective or objective examination?

5.5 Can you think of a recent instance when you examined a projectile(s) that was/were exposed to blood?

5.5.1 *[If yes]*

a. Was the projectile received from a crime scene or autopsy?

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b. List the bullet profile?

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c. Was the projectile of any value for value for comparison purposes?

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d. Were any linkages made to other projectiles?

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e. What chemical or reagent was used to clean the projectile?

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f. List the metal composition(s) and design of the projectile?

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5.5.2 Is a second qualified examiner used to verify microscopic findings verified by another qualified examiner?

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5.6 Did you ever document in your work notes that the reason why you couldn't make identification to a firearm or other projectiles was due to the projectile(s) being exposed to blood?

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5.7 How do you ensure continuity within the laboratory?

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5.8 How do you report your microscopic findings?

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5.9 What is the impact of your microscopic findings in the criminal investigation?

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5.10 What chemicals and/or reagents are being used within your section to clean projectiles covered in blood?

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5.11 Do chemical reagents have a reaction on bullets in the cleaning process?

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**Closing comments**

The interviewee is assured complete anonymity and confidentiality.



## 1. Employee data

Policy reference - Manual of Administration, Volume 2, Section 12

Surname Arendse		Given names Wayne	
Position title Assistant Section Head		Classification title PGS 20	
Employee category <input type="checkbox"/> Executive <input checked="" type="checkbox"/> Management <input type="checkbox"/> Bargaining unit <input type="checkbox"/> Excluded <input type="checkbox"/> Unclassified		Work telephone number ( 416 ) 3143230	Fax number ( 416 ) 2124748
Ministry/Agency Community Safety and Correctional Services		Branch/Section Centre of Forensic Sciences	
Mailing address 25 Grosvenor Street			
Floor/Room number 6th floor	City Toronto	Postal code M7A 2G8	

Do you require special access to fully participate in this program? Please specify.

No

## 2. Course data

Course title M-Tech: Forensic Investigation		Course code F   O   R   5   0   1	
Course location South Africa - Correspondence		Project code	
From D 15 M 04 Y 2006	Course date D 15 M 10 Y 2008	To D 15 M 10 Y 2008	
Prerequisite skills required <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			

Course type <input checked="" type="checkbox"/> Manager/Supervisor <input type="checkbox"/> Technical/Professional <input type="checkbox"/> Interpersonal/Personal <input type="checkbox"/> Secretarial/Clerical <input type="checkbox"/> Other	
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Source of program External: <input type="checkbox"/> University <input type="checkbox"/> CAAT <input type="checkbox"/> Professional Internal: <input checked="" type="checkbox"/> Ministry <input type="checkbox"/> MBS <input type="checkbox"/> Other	
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Name and address of organization delivering course, if other than Ministry or MBS

Centre For Leadership and Learning

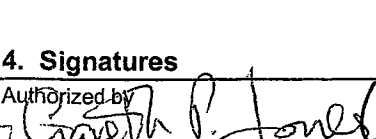

## 3. Type of assistance (Required for annual staff development report. Complete if required by Ministry procedure.)

Type of organizational support under PSA Reg. 881

23 ☐ Duty assignment 24 ☐ Credits/Paid leave 25 ☐ Repayable award 26 ☐ Leave without pay 27 ☐ Exams - Leave with pay 28 ☐ Resignation credits held 30 ☐ Tuition

Type of Assistance	Approval		Explanation of assistance A = 2007/2008 registration E = Editing will now be required for the dissertation - Noted in previous request.
	\$ Amount	% per cent	
A. Registration/Tuition	\$540.00		Special payment terms and details
B. Books	100.00		
C. Travel			
D. Accommodation			
E. Other (specify)	320.00		

Total approved \$ 960.00	Documents attached <input type="checkbox"/> Tuition fee receipt <input type="checkbox"/> Conference/Seminar registration <input type="checkbox"/> Exam results transcript <input type="checkbox"/> Proof of course completion <input type="checkbox"/> Other
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4. Signatures Authorized by 	Recommended by 	Date (d/m/y) 16/05/06
Ministry Staff Development Official	Cost centre	Ministry Nomination Priority No.

## 5. For use by Finance

## 6. For use by Management Board Secretariat (when applicable)

<input type="checkbox"/> Accepted <input type="checkbox"/> Course <input type="checkbox"/> Not eligible	Acknowledgement sent	Date (d/m/y)
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Course Coordinator	Date entered
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**1. Employee data**

Policy reference - Manual of Administration, Volume 2, Section 12

Surname Arendse		Given names Wayne	
Position title Assistant Section Head		Classification title TSS-18	
Employee category <input type="checkbox"/> Executive <input checked="" type="checkbox"/> Management <input type="checkbox"/> Bargaining unit <input type="checkbox"/> Excluded <input type="checkbox"/> Unclassified		Work telephone number ( 416 ) 3143230	Fax number ( 416 ) 2124748
Ministry/Agency Community Safety & Correctional Services		Branch/Section Centre of Forensic Sciences	
Mailing address 25 Grosvenor Street			
Floor/Room number 6th floor	City Toronto	Postal code M7A 2G8	

Do you require special access to fully participate in this program? Please specify.

Complete four subjects on a masters level within this program

**2. Course data**

Course title MTech: Forensic Investigation		Course code F   O   R   5   0   1	
Course location South Africa - <u>Online Correspondence</u>		Project code	
From D 15 M 04 Y 06	Course date D 15 M 11 Y 06	To	Prerequisite skills required <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

**Course type**
☐ Manager/Supervisor ☒ Technical/Professional ☐ Interpersonal/Personal ☐ Secretarial/Clerical ☐ Other

**Source of program**

External: ☐ University ☐ CAAT ☐ Professional Internal: ☒ Ministry ☐ MBS ☐ Other

Name and address of organization delivering course, if other than Ministry or MBS

University of South Africa, Pretorius Street, Muckleneuk Pretoria, South Africa

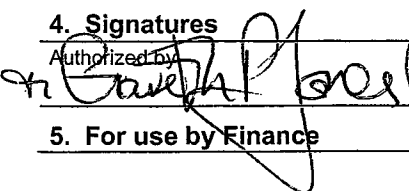
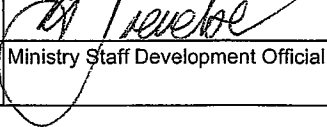
**3. Type of assistance** (Required for annual staff development report. Complete if required by Ministry procedure.)

Type of organizational support under PSA Reg. 881

23 ☐ Duty assignment 24 ☐ Credits/Paid leave 25 ☐ Repayable award 26 ☐ Leave without pay 27 ☐ Exams - Leave with pay 28 ☐ Resignation credits held 30 ☐ Tuition

Type of Assistance	Approval		Explanation of assistance
	\$ Amount	% per cent	
A. Registration/Tuition	\$350.00		B = prescribed book E = Correspondence-mailing/receiving assignments - * Editing will be required next fiscal therefore the amount will not be included in this request. Special payment terms and details
B. Books	80.00		
C. Travel			
D. Accommodation			
E. Other (specify)	200.00		
Total approved \$ 630.00			Documents attached <input type="checkbox"/> Tuition fee receipt <input type="checkbox"/> Conference/Seminar registration <input type="checkbox"/> Exam results transcript <input type="checkbox"/> Proof of course completion <input type="checkbox"/> Other

**4. Signatures**

Authorized by 	Recommended by 	Date (d/m/y) 21/02/06
Ministry Staff Development Official		Ministry Nomination Priority No.

**5. For use by Finance**
**6. For use by Management Board Secretariat (when applicable)**

<input type="checkbox"/> Accepted <input type="checkbox"/> Course <input type="checkbox"/> Not eligible	Acknowledgement sent	Date (d/m/y)
Course Coordinator	Date entered	