Information on Shotshell loading:

Recoil:

This is certainly the most discussed aspect of the shotgun shooting sport, and this is understandably so, because it determines the "comfort" of shooting hundreds of rounds in quick succession. (See section below on "Perceived recoil" and ergonomics). Because it's such a subjective issue/subject, the conclusions and recommendations are most of the time unfortunately shrouded in confusion, and corrupted by improper comparisons.

First of all we need to emphasize and acknowledge the following **important facts**:

- First, there is true recoil energy in measured Ft/lbs of the gun itself, and once the shooter becomes part of the equation, the very subjective issue of "Perceived" or "Felt" recoil.

True Recoil:

- Normal physics still do apply, and in this case Newton's Third law: For every action there is an equal and opposite reaction. **Formula: Mass of bullet + Mass of powder x Velocity (projectile) = Mass-gun x Velocity-gun.**
- If different groups of ammunition, with the **same shot mass are delivering the same velocity** in a particular shotgun, the recoil **WILL** be the same.

"Perceived" or Felt" recoil:

Ergonomics

- Because the shooter forms a part of the "launching platform", this reaction of the total platform will be as diverse as there are shooters.
- One must see the ammunition, gun and shooter as a three part "system" (Combination) forming this "launching platform". The way these three parts interact and interface, will determine "**how"** the recoil takes place, and how the shooter will **"perceive"** or **"feel" "experience"** the recoil. (Notice the emotional aspects)
- Since the body is the heaviest part of the total recoiling mass, which anchors the system to the ground, it has the most inertial resistance. Since the body is soft, that part of the body interfacing directly with the shotgun, will absorb the energy long before the body starts moving (displacing). Thus the maximum absorption takes place in the few inches of muscle and tissue directly behind the butt.
- That's why sometimes small and minute differences in gun design, hold/stance and balance will lessen the effects of recoil, and this will eventually directly determine the level of bruising/punishment, and as such the endurance of the shooter. This endurance-threshold will directly impact the shooters abilities to remain focused and accurate.
- This "endurance-threshold" is different for each shooter, and are determined by various aspects of the individual's body structure re muscle, developed muscle (training), body weight and length (Tall = usually flexible, absorb energy better, softer feel, or short stocky = rigid hard recoil. The psychological make-up/preparedness (training) must also be considred.
- Apart from the above aspects, every person has a natural pain-threshold (nerves), and some will be able to endure more than others, before it will start affecting their shooting discipline and results.

Ammunition:

- As can be seen from the formula pressure is not part of the equation. Therefore the "peak"-value published in load guides does not really mean anything. However, Ammunition can be assembled (combination) to deliver similar velocities = true recoil, with a pressure impulse which can be slightly altered, having the same total impulse, but over a slightly longer time base. These changes can them be perceived as being "softer". However, we must again stress the fact that the comparison must always be fair and clinical (apples with apples) re velocity. A proper average can really only be determined over a 10 and 20 round test, fired at different time's, and days, to include day to day variation etc.
- This can be achieved by altering any one of the components in the above ammunition "subsystem", which comprises of the primer, case/hull, wad, powder/burn-rate and the weight of the shot.
- This effect is the result of the combination and never one of the components only. This can only be properly done by thorough experimentation with different primer/s, cases, crimp /assembly methodology (see section below), wad design/s /make, wad tension (assembly), and the weight the shot.

Important things to remember and do to discern what loads are softer and
The importance of measuring the velocity.

- Do not assume the velocity for your conditions is the same as the published data, even if you are duplicating the exact same combination re components i.e. the case/hull, powder type, powder charge, shot weight etc as recommended by any load guide.
- This real difference can only be determined by actually measuring the velocity, for the conditions, components and weapon system as used by the reloader/shooter.
- When loads are compared and the level of "perceived-recoil" has been determined for a particular shooter, have the velocity measured to confirm that the softer load are actually not merely a slower velocity. Since the formula for Kinetic Energy is half the mass x velocity squared, the shooter will detect a difference in recoil within a few feet per second. Especially the seasoned professional shooters that have developed an above average sensitivity and ability to sense variations between "loads".

Background and basic Fundamentals.

- The fundamental difference between a shotshell cartridge and a typical centre fire rifle cartridge is, that the efficiency of the shotshell cartridge is 100% dependant on the round itself. By this we mean that all the "resistive forces" must be generated within the confines of the round itself. No assistance is provided by the gun.
- The reason for this is that the Maximum Peak Pressure is reached long before the base of the shot/wad assembly has left the case. (In the case of a CF rifle cartridge, the peak pressure is achieved when the bullet is engraved, therefore the large contribution, as a result of leade/free-bore dimensions on the combustion process. (i.e. bullet/bore interface fit, bullet hardness, bearing surface etc).
- The reason for this is that the critical engraving force which is so important to the dynamic combustion process present in a CF rifle caliber is totally absent in a shotgun.
- Shotgun and typical straight-case handgun calibers are actually basically the same in their fundamental ratios and dynamics. A shotgun can be described as an oversize low-pressure handgun caliber. That's why the same powders are used in shotgun and handgun calibers.
- This means that the efficiency re ignition and the subsequent increase in pressure, is totally controlled by the integral configuration and assembly of the round itself. These constitute the main inertial mass (shot mass), the initial internal volume (wad design), the dynamic collapse (primary expansion) of the internal volume (collapsible section of the wad), plus the displacing of the internal assembly and the unfolding of the fold/crimp (secondary/Final expansion).
- The way this COMBINATION interacts, will determine the efficiency Pressure impulse (Profile and time-base) and the Peak-pressure vs Velocity ratio (P/V). The resistive force, presented by friction in a shotgun is negligible.

C**rimping: (Assembly)**

- This is certainly one of the most important aspects of the Shotshell reloading process.
- The influence of crimp on the ballistics is often ignored, and assumed to be of lesser importance than primers and wad make/design.
- The fact is that the effect of Crimp-strength can totally overshadow the influence of the other components and parameters. This is controlled by the following:
    - Crimp depth: Depth setting on crimping machine.
    - Condition of the case: Material hardness resilience.
    - Wad: Length, Stiffness and rigidity/flexibility of collapsible section.
    - Wad Tension: Pre-tension/compression setting on crimping machine.
- Some reloader's want to extend case life and they tend to crimp as shallow as possible, and with the least crimp strength possible. However, this practice can be problematic if the improper combination of primer, case, wad and powder is used. Example: If a "soft" combination is used, it can lead to underperformance, or in extreme cases, bloopers. It is always wise to use a strong a crimp as possible, for any particular load/combination.

Primers:

- It is well known that different primers deliver different energy levels. The way each company manufacturers and formulates the chemical composition, and configures the hardware (metallic) parts of the primer, all plays a major role in how the primer will deliver the energy to the powder.
- Again, we must emphasize that it's all about the particular combination, and whether a change in primer will show a difference in ballistics.
- Shotgun primers are very sensitive to firing pin energy. This is due to the proportionally large displacement/deformation that must take place when the primer's cup is crushed.
- It is extremely difficult to pin the data down to a standard one load, where primer X will always deliver higher performances than Primer Z. AAC developed our loads using a standard typical primer. If all conditions are the same, the difference between primers will rarely be dangerous. It is obvious that if the load one is using, are already running at the maximum level with primer X, it would be unwise to merely change the primer and continue loading. This is also true for any change in component or procedure.
- Once any component or procedure is changed, the combination will react differently. The proper way to proceed is to reduce the load by about 0.5grain to 0.7grains, and then confirm the performance by measuring the velocity or sensing the recoil/flight time. The reloader can then adjust back to the same velocity/recoil level, by increasing or decreasing the charge mass, or by adjusting to a stiffer softer wad or decreasing or increasing the crimp.

Volumetric loading/dispensing:

- Always confirm the "thrown weight' from any bushing, bar etc on a scale.
- There are just too many variables that can influence volumetric measuring, of powder.
- These are:
    - The physical action with which the loading machine is operated.
    - The atmospheric conditions especially Relative Humidity (RH). This is especially true of single base powders which are very hygroscopic. AAC powders S1000 and S1250 are single base powders; N100 is a double base powder.