John Fildes, Ph.D.
Spotlight Business Consulting LLC
www.SpotlightBC.com
jfildes@SpotlightBC.com
(630) 248-0836

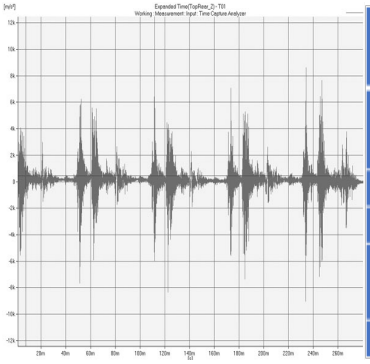
Investigating Small Arms' Issues

Dr. Fildes has extensive and unique experience with investigations small arms' issues. Small arms contain a variety of components that execute several different actions during the firing cycle. Upon firing, expansion of gas unlocks the bolt and moves it rearward, which compresses the action spring. As the bolt slide rearward, the cartridge is expelled. The bolt's rearward travel slows and ultimately the bolt reverses its direction of travel, sliding forward under the force of the action spring that was compressed during the rearward travel. As the bolt slides forward, the next round is stripped from the magazine, and it is chambered and the bolt locks as the forward motion of the bolts comes to an end and the action spring has expended its stored energy.

The Role of Materials and Acceleration Monitoring

What should be taken away from this description is that some of the actions of the weapon are driven by the expansion of gas from the firing, which is an impulse type force (quick rise time, high peak force, short duration), while other actions are driven by the energy stored in a spring, which is a sustained, non-impulse force (relatively consistent velocity and force, far longer duration). The components involved in the various actions can have different coatings, and are exposed to different temperatures and forces, so the various components may wear differently and at different rates. Wear of components increases friction through an increase of surface roughness, collection of abrasive debris, and sloppiness caused by an increase in component tolerances. Increased friction robs the energy that is needed to drive the actions of the weapon and can cause jams and double feeds of the next round.

The motion of the various actions of a weapon cause acceleration that can be measured. Dr. Fildes has developed unique methods to analyze the accelerations and measure the timing of the various actions. This can also identify increases in friction and measure the timing changes they cause in the various actions, and in this way identify the components that are wearing and assess the rate at which they are wearing. Dr. Fildes has also used high speed photography to add insight that is complimentary to the measured accelerations. He has also measured the impact of coatings on the timing of the actions and assessed their wear and effectiveness.



Region	Onset Time, ms	Duration, ms	Action
1	0	6 - 7	Firing. Gas expansion unlocks the bolt, moves it rearward compressing the action spring.
2	7	18 - 23	Bolt slides rearward ejecting the cartridge.
3	25 - 30	5	Reversal of bolt motion.
4	30 - 35	34 - 43	Bolt slides forward stripping the next round from the magazine.
5	64 - 78	6 - 7	Round is chambered, bolt locks.

Experience and Case Study

Dr. Fildes was the President of the federally funded, not for profit Institute of Tribology and Coatings. Tribology is the science of friction, wear, and lubrications. Dr. Fildes worked in collaboration with the Army's Benet Weapons Laboratory and the Department of Defense's Small Arms Joint Program Office at Picatinny Arsenal, which handled small arms procurement and oversaw small arms R&D for all of the services.

Dr. Fildes' work on small arms was instrumental in identifying a coating that was shown by testing at Picatinny Arsenal to significantly extend the life of the weapon and to extend the time between cleaning and make cleaning far easier. This coating is undergoing further evaluation by the Army and by a small arms manufacturer. As part of this work, Dr. Fildes conceived or and developed a highly effective test for evaluation the abrasion resistance of coatings. This work was reported in the premiere Tribology Journal Wear, and also presented at the conference Wear of Materials, which is the premiere tribology conference held every 5 years.

Dr. Fildes' also conceived of the use acceleration monitoring to characterize the actions of small arms and monitor the friction and wear of their materials. Dr. Fildes developed highly sophisticated artificial intelligence methods, which were required to extract useful information from the raw acceleration signal. In fact, the analysis of the acceleration signal is the make or break issue in the success of acceleration monitoring of the actions of small arms.

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Dr. John Fildes

John Fildes, Ph.D. is uniquely qualified through experience and training to provide insight on the role of science and engineering in litigation. In addition to conducting highly successful technical investigations for high-stakes litigation involving a wide spectrum of metals and materials, chemical processes, and sensors and controls, he also organized and conducted over $27.5 million in funded projects including research, development, and collaborations involving Government labs, large companies, and leading universities. John was instrumental in establishing and served as Director of the 501©3 Institute of tribology and Coatings federally funded Small Arms Tribology and Materials Characterization Project, which was a was a highly successful collaboration involving University staff and professors, the Army's Benet Weapons Laboratory, the Joint Services Small Arms Program Office at Picatinny Arsenal, several small arms manufacturers, and small companies. He is a doctoral-level scientist who has 50 published papers, reports and presentations, and has 3 patents. John's credits involve:

- *John served as the principal investigator for a multi-million-dollar, multi-year project funded by the U.S. Army to analyze the failures of weapons due to abrasive wear and to evaluate coatings and lubricants and develop new friction and wear test methods for improving the functioning of weapons.*
- *Conducts failure analysis and diagnostics of the underlying basis for materials related performance issues with machinery and weapons systems.*

Our gatekeeper approach provides:

- ✓ *The quickest and best possible outcome.*
- ✓ *A unique opportunity for early resolution based on knowing 60% to 80% of what might ultimately be uncovered.*
- ✓ *Superior technical insight for even complex and multidisciplinary issues.*
- ✓ *A reliable basis for expert testimony that meets rules for admissibility established by the Supreme Court.*
- ✓ *A strategic advantage with corporate clients since they already appreciate that this approach improves outcomes and lowers costs through use of all existing knowledge and elimination of duplication.*

Our gatekeeper approach uses information research and analytics early in technically related cases and *establishes the* key *MAKE OR BREAK technical issues and everything that is known about them.* This approach requires someone who has the extensive experience with both contemporary R&D methods and litigation-related expert witness investigations so as to adapt the corporate R&D technical investigation process to the unique aspects of litigation expert witness investigations. Our experience to do this is reflected in our process to bring litigators the R&D technical investigation techniques that have revolutionized industrial R&D, providing litigators with the better outcomes and lower costs that industry has achieved in overcoming similar investigation challenges.

1. Define the Technical Issues – Inspections, insight from litigation parties, and broad literature searching are conducted to gather information from prior related cases, trade association publications, patents, manufacturer's marketing materials and reports, and Internet forums to establish the key technical issues.

2. Use Analytics to Establish What is Known About the Technical Issues – The data gathered above is analyzed using contemporary tools for data mining and modeling to adapt the available data and fill the gaps that always exist in litigation investigations.

(3) Reliably Define the Testing Needed – The data that has been collected and analysis that has been done ensures that: existing knowledge is not recreated, the remaining work is properly focused, and all involved parties understand the challenges, methods, and progress.

(4) Coordinate, Oversee, and Effectively Communicate – This approach ensures that the overarching technical concepts are effectively framed and communicated, and it eases report preparation. The results are well supported, clear, and compelling even to people not knowledgeable of science and engineering.