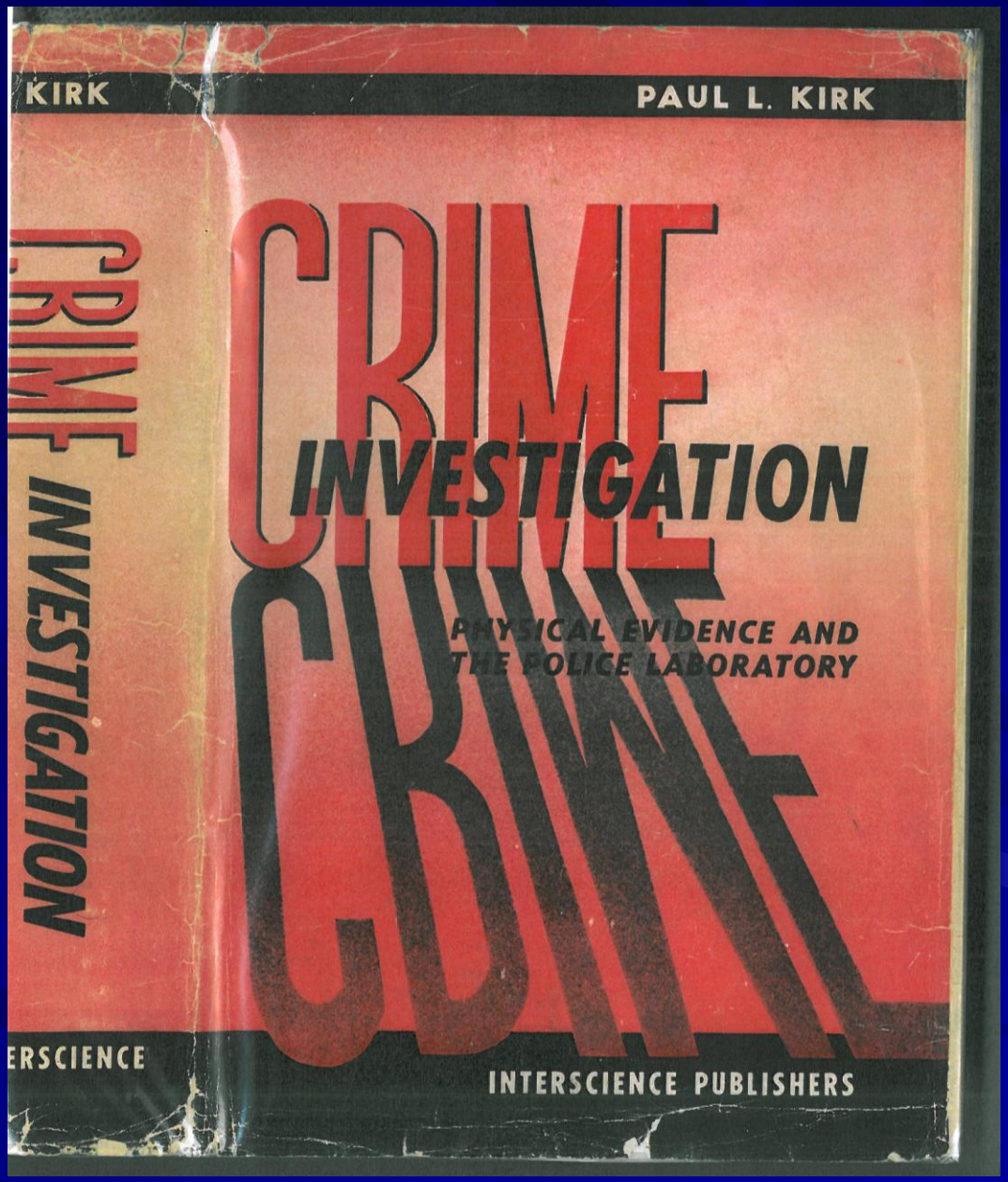
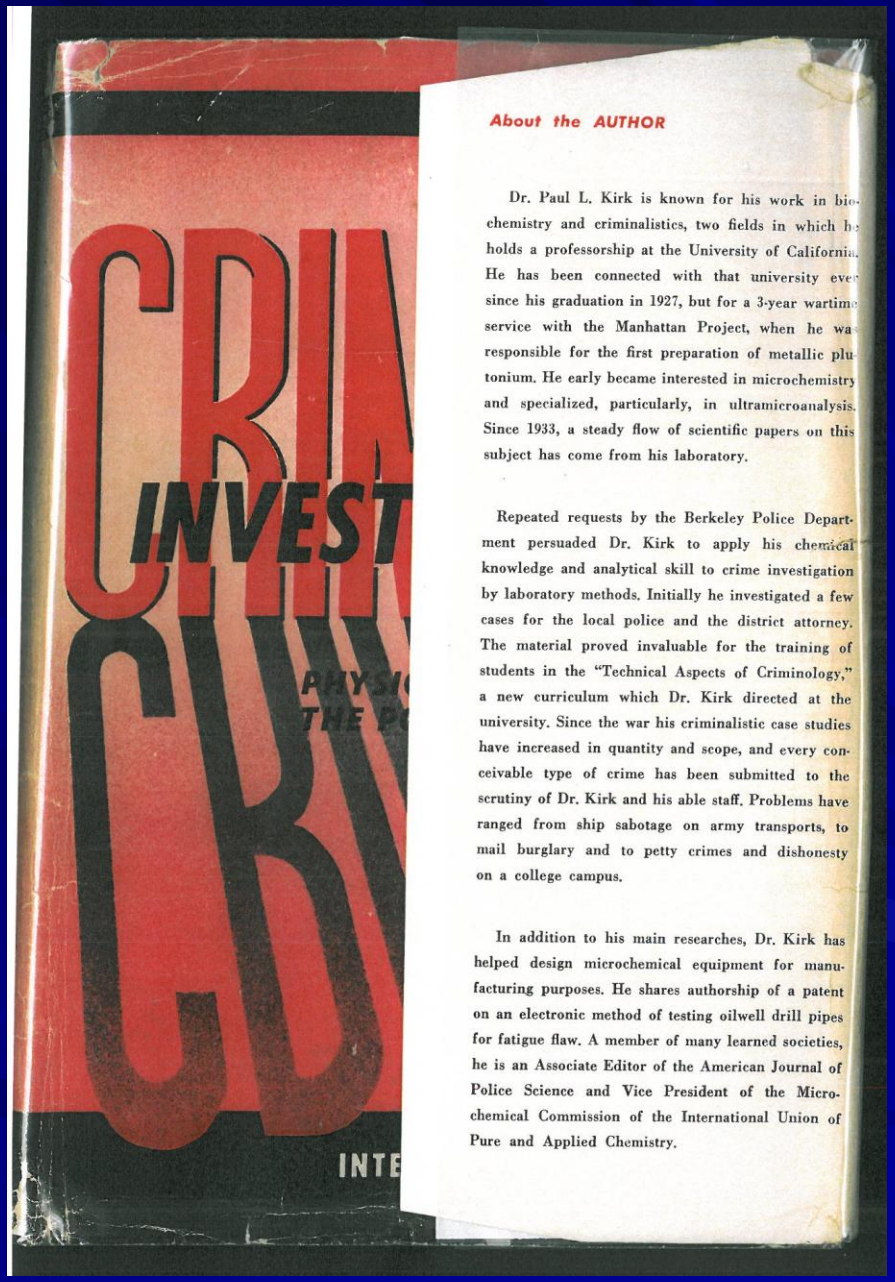
The Development of Numerical Criteria for the Identification of Striated Toolmarks by Empirical Testing

by

Al Biasotti and John Murdock

NIST/OLES Conference - July 10 & 11, 2012
"Measurement Science and Standards
in Forensic Firearms Analysis"


KIRK
PAUL L. KIRK
CRIME INVESTIGATION
CRIME
INVESTIGATION
PHYSICAL EVIDENCE AND
THE POLICE LABORATORY
ERSCIENCE
INTERSCIENCE PUBLISHERS



About the AUTHOR

Dr. Paul L. Kirk is known for his work in biochemistry and criminalistics, two fields in which he holds a professorship at the University of California. He has been connected with that university ever since his graduation in 1927, but for a 3-year wartime service with the Manhattan Project, when he was responsible for the first preparation of metallic plutonium. He early became interested in microchemistry and specialized, particularly, in ultramicroanalysis. Since 1933, a steady flow of scientific papers on this subject has come from his laboratory.

Repeated requests by the Berkeley Police Department persuaded Dr. Kirk to apply his chemical knowledge and analytical skill to crime investigation by laboratory methods. Initially he investigated a few cases for the local police and the district attorney. The material proved invaluable for the training of students in the "Technical Aspects of Criminology," a new curriculum which Dr. Kirk directed at the university. Since the war his criminalistic case studies have increased in quantity and scope, and every conceivable type of crime has been submitted to the scrutiny of Dr. Kirk and his able staff. Problems have ranged from ship sabotage on army transports, to mail burglary and to petty crimes and dishonesty on a college campus.

In addition to his main researches, Dr. Kirk has helped design microchemical equipment for manufacturing purposes. He shares authorship of a patent on an electronic method of testing oilwell drill pipes for fatigue flaw. A member of many learned societies, he is an Associate Editor of the American Journal of Police Science and Vice President of the Microchemical Commission of the International Union of Pure and Applied Chemistry.

QUANTITATIVE ULTRAMICROANALYSIS

Paul L. Kirk, Ph.D.
Professor of Biochemistry
University of California

1949

John Wiley & Sons, Inc., New York
Chapman & Hall, Limited, London

PAUL L. KIRK

Berkeley, California
November, 1949

CONTENTS

CHAPTER 10

Physical Methods

In the field of microgram chemistry it is necessary at times to determine the physical constants of very small quantities, though not necessarily as a portion of a direct quantitative analysis. Many compounds have been prepared in microgram quantities in connection with the study of the chemistry of the transuranic elements, the details of which may be found in specialized publications of the Manhattan project. In order to study these small preparations, many physical constants were determined, thereby demonstrating the utility of well-established techniques when applied to new problems. In the field of biochemical microgram analysis it is often equally desirable to determine physical properties. Such procedures as the determination of melting points, boiling points, refractive indexes, and density have been used routinely with milligram quantities for many years. Their application to microgram quantities requires merely the adaptation to the smaller amounts, and some of these adaptations also are standard procedures that have been employed in some laboratories over considerable periods of time. Here are discussed some of the alterations in standard technique which are necessary when the quantity of material is so small as to preclude the use of conventional procedures.

MELTING-POINT DETERMINATION

Capillary-tube methods normally require more material than is available to the microgram chemist. Hot-stage methods for use with the microscope, however, are entirely suitable even for the most minute quantities. Various designs of melting-point blocks for the microscope stage have been described, and some of them are available commercially. They depend on heating electrically a block of metal carrying the sample and a thermometer bulb (or thermocouple). The compound is observed microscopically to determine when it melts, and any sample that can be viewed with the microscope can be measured.

STATISTICAL ANALYSIS OF BULLET COMPARISON

(Preliminary Report)

for

Criminology 299

by

A. A. Biasotti

— 8 pages —

Berkeley, California

June 1, 1951

most cases is overwhelming! However, as the number of characteristics on the bullet are diminished by obstacles which it may encounter after leaving the barrel the expert can be less certain that the bullet came from the same gun. For this reason the expert must have some statistical, empirically tested, basis for qualifying the conclusion which he may make when the similarity is not overwhelming. The law requires that the expert be certain beyond and to the exclusion of all reasonable doubt before stating that two bullets were fired from the same gun. But what constitutes reasonable doubt, especially when the total number of matching characteristics is small? If, however, the expert could qualify his conclusions in terms of degrees of probability when he is not certain beyond all reasonable doubt his opinion may carry its just weight and be added to the probability of other fragments of physical evidence so that a cumultive probability would prove beyond all reasonable doubt the guilt or innocence of the accused.

The purpose of this study is then, to give the criminalist some basis for establishing what constitutes a match and what degree of probability can be attached.

The relative frequency of occurrence of consecutive series as will be compiled in this study could be used directly as empirical findings without deriving any concept of probability; but if this were done, the data would apply only to the particular type of gun and ammunition used in this particular study. Then similar studies would have to be conducted for every gun of different manufacture of the same caliber and for every different type of ammunition to be significant. If, however, a mathematical model were constructed, a concept of probability derived, then the concept of probability could be applied for all guns of the same caliber, regardless of manufacture, utilizing similar ammunition, e.g. lead alloy, metal jacketed, etc. In any case the concept of probability derived in any particular empirical study must eventually be substantiated by empirical studies utilizing many types of guns and ammunition. It is hoped that this study will lay the foundation for such a series of studies.

D. Experimental

The problems involved in laying the groundwork for a study of relative frequency can best be discussed under the two general catagories : technical and statistical.

1. Technical problems:

There were several technical problems which had to be solved before any attempt could be made in conducting a statistical study. Illumination and alignment were the two principal ones.

a. Illumination:

It is imperative in a statistical study that as many variables be kept constant as possible so that the variation in the variable under observation can be studied. The variable being studied in this work is the occurrence of matching consecutive lines, and illumination has been the most difficult variable to control. When using the standard technique of oblique reflected illumination to produce a reflected image of the characteristic markings on the circumference of a bullet the results are far from ideal. Since the image obtained is an alternating series of high-lights and shadows, a slight deviation in the angle or the intensity of the illumination will alter the appearance of the image. It is true that this derivation in illumination must be large before the gross characteristics are perceptibly changed, but it must also be remembered that the loss or addition of only one minor characteristic will make quite a great difference in the significance of a consecutive series; viz., a consecutive series could be counted as a straight match of 12 or as several separate series, 4 and 8, or 2,2,4 and 4, etc.

Individual spot lamps were first tried and proved to be very unsatisfactory and very impractical. After a futile attempt at standardizing the positioning and intensity of the individual spot lamps, a single 12-inch fluorescent lamp provided with about a $\frac{1}{4}$-inch "eskimo slit" was used as a single uniform source of illumination. This arrangement provided constant illumination which could easily be positioned

BULLET COMPARISON

A STUDY OF FIRED BULLETS, STATISTICALLY ANALYZED

To John Murdock
7/6/95
Al Biasotti

A Thesis

Presented to

the Faculty of the Graduate School

of Criminology

University of California

Berkeley

In Partial Fulfillment

of the Requirements for the Degree

Master of Criminology

---

by

Alfred A. Biasotti

February, 1955

Personal copy returned to A. A. Biasotti
L. "Jack" Hoon 8/24/90

Tool Manufacture -
From a Criminalists Point of View

by

John E. Murdock

Dec. 10, 1967

Submitted as Course Requirement for

Criminology 299

Fall Quarter 1967

Instructer In Charge: Dr. Brian Parker

Copy to Blessitt July 20, 1978

An Objective, Empirical Approach to Tool Mark Analysis

by

John E. Murdock

A term paper
submitted as course requirement for

Criminology 289

Spring Quarter - 1968

Professor in Charge: James W. Osterburg

TABLE III

Operator Variability in Comparison
of Characteristics in Known Non-Matches*

File No. 6	No. of Matching Characteristics***	No. of Consecutive Matches ***			No. of Non-Consecutive Matches ***			Total No. of Matches ***		
	5	1		1				1		1
	4									
	3	2		1	1			3	1	1
	2		4		4			4	3	
	1				20	8	12	20	7	12
No. of Scans **		84	83	90	84	83	90	84	83	90
Operator		SM	FB	JM	SM	FB	JM	SM	FB	JM
Magnification		16	10	30	16	10	30	16	10	30

* Known non-matches - The data in this table is expressive of occurances observed at every position of horizontal 25-tab movement except those positions where the 25-tab characteristics were in juxtaposition with their counterparts in the parent film.

** A heavily marked area near the bottom of the negative was examined and a twenty five mark section (counting voids) was marked off and the negative cut into just above these marks. The tab was next placed so that the left edge of the first dark line of the chosen group of 25 matched, or was in line with the left edge of the first dark mark in the parent section of the film. A visual determination was then made of how many lines or voids matched between the 25-tab and the parent film. Shifting to the right, from line to line, was continued until the right side of the 25-tab first extended beyond the right side of the parent film.

*** Characteristics - Either any one of a series of lines, varing in intensity from light grey to black, or any one of a number of blank areas, termed voids, appearing parallel to one another on the film.

CALIFORNIA STATE UNIVERSITY, SACRAMENTO
Criminal Justice Department

1976

BRUCE HORAN
95/100

Criminal Justice 147
Comparative Evidence and Its Evaluation

G.W. Roche
Instructor

STRIATED MARK INTERPRETATION

Striated marks, such as those produced by a screwdriver or by a gun barrel, often constitute important physical evidence. Sometimes comparison of evidence marks with test marks clearly indicate that two marks were produced by the same tool or instrument. However, in many instances conclusions as to identity or non-identity are not easily demonstrated. Very little objective criteria for interpretation of striated marks exist. Conclusions usually are based on the skill and experience of the examiner. In this laboratory exercise the student will study some of the ways in which objective criteria might be applied. The instructor will discuss the study of idealized striated marks and their comparisons using models. Students will reduce the striated mark to an ideal state and study a theoretical basis for evaluation.

Exercise No. 1 - INTRODUCTORY EXERCISE

Purposes:

1. To introduce the student to the concept of "consecutive matching lines".
2. To allow the student to make some observations regarding the "per cent matching lines" concept.
3. To determine, in an empirical way, how much similarity might be encountered "by chance" between two striated marks produced by different tools.

Materials:

linen tester
Striated Mark Set

Assignment:

Compare two striated marks produced by different tools and determine the frequency of the chance occurrence of consecutive matching striae. Repeat with two additional sets of marks.

Procedure:

Obtain a Striated Mark Set from the instructor. The set consists of six photo copies of striated marks. The marks were produced by scraping different surfaces of 120, 220 and 320 grit sandpaper over cleared photographic film. All the photocopies have been enlarged to the same magnification. Each photocopy is identified with the grit number (120, 220 or 320) plus another number (1, 2, or 3). The latter numbers refer to different marks (ie., different tools) within the same grit size. The letter designations (A, B or C) are to be ignored for this exercise. The date designation (12/75) may also be ignored.

Please return to — DAN MURDOCK

Rev. 8/76

Results and Conclusions:

Moran – 1976
at Sam State

TABLE I

Marks To Be Compared	Line Count (entire mark)	Frequency of Consecutive Lengths (entire mark)					Average Line Count	Per Cent Matching Lines
		singles	doublets	trip.	quad.	other	$\frac{\Sigma \text{ L.C.}}{2}$	total matching lines/average line count
GRIT 3170 120-1	150 149 148 $\bar{x} = 149$	6	1	—	—	—	149 + 110 2 / 259 = 130	$\frac{8}{130} = 6.1\%$
120-2 (red)	108 110 113 $\bar{x} = 110$							

TABLE II

Marks To Be Compared	Line Count (entire mark)	Frequency of Consecutive Lengths (entire mark)					Average Line Count	Per Cent Matching Lines
		singles	doublets	trip.	quad.	other	$\frac{\Sigma \text{ L.C.}}{2}$	total matching lines/average line count
120-1	$\bar{x} = 149$	6	—	—	—	—	149 138 121 $\bar{x} = 144$	$\frac{6}{144} = 4.1\%$
120-2 (black)	137 138 139 $\bar{x} = 138$							

AFTE Journal

VOLUME 16 JANUARY 1984 NUMBER 1

THE ROLE OF THE FIREARM AND/OR TOOLMARK EXAMINER IN FORMULATING OPINIONS RELATIVE TO EVIDENCE WHICH OTHERWISE STANDS MUTE BEFORE THE BAR OF JUSTICE SIGNIFICANTLY AFFECTS THE ADMINISTRATION OF JUSTICE. FULLY QUALIFIED FIREARM AND/OR TOOLMARK EXAMINERS, BASED ON THEIR TRAINING, RESEARCH, AND ACQUIRED KNOWLEDGE, STAND PREPARED TO GIVE VOICE TO THIS OTHERWISE MUTE EVIDENCE.

IN RECOGNITION OF THE NEED FOR THE INTERCHANGE OF INFORMATION, METHODS, DEVELOPMENT OF STANDARDS, AND THE FURTHERANCE OF RESEARCH, A GROUP OF SKILLED AND ETHICAL FIREARM AND OR TOOLMARK EXAMINERS MET TOGETHER REGULARLY PRIOR TO 1969. IN THAT YEAR THEY FORMED THE ASSOCIATION OF FIREARM AND TOOLMARK EXAMINERS RECOGNIZING THAT FIREARM AND TOOLMARK IDENTIFICATION, THOUGH INVOLVING SIMILAR DISCIPLINES, REQUIRE SEPARATE AND DISTINCT BASIC KNOWLEDGE.

Association of
FIREARM AND TOOL MARK EXAMINERS

AFTE 2/24/84

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EDITOR'S NOTE

This issue, you will note, contains segments of the California DOJ Training Syllabus. This reference material is a welcome augmentation to our AFTE Training Manual. The individuals involved in this project has spent a great deal of time and effort in producing this work and I thank them for sharing the information with all AFTE members.

The 15th Anniversary Meeting will be held this June (10-15) in New Orleans. Please check the information found on pages 7 through 10. Please plan to attend and participate in our Association's 15th Anniversary.

The April issue of the AFTE Journal will contain some excellent material to include the 'Reader-Reporter' reports for the entire year of 1983. Lonny Harden and his committee are to be thanked for their efforts in reading the vast amount of material.

Finally - there is always a need for articles and information for the Journal. Please consider sharing your information with the entire membership. Thank you for your assistance.

James E. Hamby
Editor

CALIFORNIA DEPARTMENT OF JUSTICE

DIVISION OF LAW ENFORCEMENT

BUREAU OF FORENSIC SERVICES

TRAINING SYLLABUS FOR FORENSIC FIREARMS & TOOLMARK IDENTIFICATION

1982

COORDINATED AND EDITED BY

A.A. BIASOTTI

F.A.J. TULLENERS

Editor's Note: The following information was submitted by Al Biasotti for sharing with the entire AFTE membership. The information contained in Module #1 - Fundamental Knowledge and Skills Common To All Forensic Sciences, and Module #2 - Forensic Firearms and Toolmark Identification, are a valuable companion to the AFTE Training Manual (published by the Association of Firearm and Toolmark Examiners).

It is anticipated that Modules Numbers 3 through 7 will be made available to the membership as they become available. Any member having questions or comments are encouraged to colntact Al Biasotti directly. Al's telephone number is (916) 739-5484.

Principal Authors:

Module #1, 2:	A.A. Biasotti (DOJ, Sacramento) J.E. Murdock (Contra Costa County Sheriff)
Module #3	:	F.A.J. Tulleners (DOJ, Riverside) R.G. Cranston (DOJ, Eureka) R.M. Ralston (DOJ, Oroville)
Module #4	:	P.M. Dougherty (San Mateo County Sheriff) W. Corazza (DOJ, Santa Rosa)
Module #5	:	J.R. Davidson (San Bernardino County Sheriff) J. Hamman (DOJ, Fresno) P. Lum (DOJ, Salinas)
Module #6	:	S. Glass (DOJ, Modesto) W. Johnston (DOJ, Redding)
Module #7	:	J.E. Murdock (Contra Costa County Sheriff) C.A. Young (Oakland Police Department)

STRIATED MARK INTERPRETATION

The following is an adaptation of an exercise developed by Professor G. W. Roche for Criminal Justice 147, (Comparative Evidence and its Evaluation), California State University, Sacramento, Criminal Justice Department (8/76).

Striated marks, such as those produced by a screwdriver or by a gun barrel, often constitute important physical evidence. Sometimes comparison of evidence marks with test marks clearly indicate that two marks were produced by the same tool or instrument. However, in many instances conclusions as to identity or non-identity are not easily demonstrated. Very little objective criteria for interpretation of striated marks exist. Conclusions usually are based on the skill and experience of the examiner. In this laboratory exercise the student will study some of the ways in which objective criteria might be applied. The instructor will discuss the study of idealized striated marks and their comparisons using models. Students will reduce the striated mark to an ideal state and study a theoretical basis for evaluation.

Exercise #1:

Introductory Exercise

Purpose:

To introduce the student to the concept of "consecutive matching lines".

To allow the student to make some observations regarding the "per cent matching lines" concept.

To determine, in an empirical way, how much similarity might be encountered "by chance" between two striated marks produced by different tools.

Materials:

linen tester, fingerprint glass or other low power (i.e., 3 to 5x) magnifying glass
Striated Mark Set

Assignment:

Compare two striated marks produced by different tools and determine the frequency of the chance occurence of consecutive matching striae. Repeat with two additional sets of marks.

Procedure:

Obtain a Striated Mark Set from the instructor. The set consists of six photo copies of striated marks. The marks were produced by scraping different surfaces of 120, 220, and 320 grit sandpaper over cleared photographic film. This film is then used as negative to produce 8 X 10 photographic enlargements. All the photocopies have been enlarged to the same magnification. Each photocopy is identified with the grit number (120, 220, 320) plus another number (1, 2, or 3). The latter numbers refer to different marks (i.e., different tools) within the same grit size. The letter designations (A, B, or C) are to be ignored for this exercise. The date designation (12/75) may also be ignored.

Start with the 120 grit set. Note that photocopy 120-1 has three vertical lines designate A, B, and C. Carefully fold copy 120-1 along the vertical line A. This folded edge represents the mark to be compared with copy 120-3. Do not fold copy 120-3. In the comparison of per cent matching lines and frequency of consecutive matching lines, it is essential that the following uniform and precise procedure be followed.

SUMMARY OF RESULTS OBTAINED ON THE STRIATED MARK COMPARISON EXERCISE

(Advanced Firearms ID Course - Sacramento March 17 & 18, 1977)

by A. Biasotti - CA DOJ

Mark & Position Counted	AV. Total Line Count/% Match/and Number of Consec. 2,3,4, etc. Match Lines						All Counts
	120-1/3		220-2/3		320-2/3		(1) Av % MATCH (2) Range (3) Largest Consec Run Count
Examiner	A/A	A/B	A/A	A/B	A/A	A/B	
1. Cortner	127 22 12/3/0	140 18	156 20 11/3/0	152 15	163 13 4/2/0	159 13	(1) 17% (2) 13-22% (3) Three
2. Asbury	120 13 8/0	124 15	148 12 5/0/1	143 14	137 9 5/2/0	146 10	(1) 12% (2) 9-15% (3) Three
3. Malaga	134 8 1/0	134 4	154 5 0/0	150 3	158 3 2/0	160 5	(1) 5% (2) 3-8 (3) Two
4. Frank	120 17 14/6/1/0	105 16	143 10 6/2/0	143 11	149 7 3/0	140 10	(1) 10% (2) 7-17% (3) Three
5. Glass	107 8 1/2/0	111 15	147 9 3/0	150 11	171 23 11/4/1/0	156 14	(1) 8% (2) 8-23 (3) Four
6. Woycheshin	92 10 4/1/0	93 11	110 10 2/0	110 8	101 20 6/2/0	106 19	(1) 13% (2) 8-20% (3) Three
7. Gima	129 28 14/4/0	132 24	152 25 7/5/0	151 15	146 15 5/0	152 12	(1) 16% (2) 12-28 (3) Three

GROUP AV. 12%

SUMMARY OF RESULTS OBTAINED ON THE STRIATED MARK COMPARISON EXERCISE

(Advanced Firearms ID Course - Riverside March 22 & 23, 1977)

by A. Biasotti - CA DOJ.

Mark & Position Counted	AV. Total Line Count/% Match/ and Number of Consec. 2,3,4, etc. Match Lines						All Counts (1) AV % MATCH (2) Range (3) Largest Consec. Run Count
	120-1/3		220-2/3		320-2/3		
Examiner	A/A	A/B	A/A	A/B	A/A	A/B	
1. Fickies	120 16 6/1/0	128 19	141 21 7/3/0	138 16	150 13 4/0	147 17	(1) 17% (2) 13-21% (3) Three
2. Casper	115 6 2/0	124 7	155 4 3/0	155 7	150 6 3/0	152 6	(1) 6% (2) 4-7 (3) Two
3. *Mauzey	117 ~~37~~ 14 ~~28/3/1/0~~ 26/3/0	120 ~~35~~ 13	145 ~~39~~ 17 ~~13/6/3/1 (one??)~~ 12/3/0	144 ~~38~~ 10	151 ~~40~~ 10 ~~14/5/2/2/2~~ ~~23/4/1/0~~	151 ~~33~~ 13	(1) ~~36%~~ (2) 30-40 (3) ~~Six~~ FIVE
4. Hamman	118 6 2/0	122 6	150 3 3/0	154 8	183 4 1/0	179 1	(1) 5% (2) 1-8 (3) Two
5. Hoobler	97 21 5/2/0	97 16	127 13 6/1/0	127 12	113 11 5/0	113 13	(1) 14% (2) 11-21 (3) Three
6. Matty	126 10 1/0	124 7	125 5 0/0	133 5	111 5 1/0	123 7	(1) 7% (2) 5-10 (3) Two
7. Sham	125 14 10/6/4/0	125 17	155 21 9/3/1/0	154 15	149 20 5/2/1/0	156 21	(1) 18% (2) 14-21 (3) Four
8. Rakestraw	123 16 5/4/0	128 17	151 12 7/3/0	149 11	154 10 4/4/(one 6?)	150 10	(1) 13% (2) 10-17 (3) Three
9. Cassidy	128 16 3/0	126 22	158 25 5/2/1/0	159 28	152 9 3/2/0	154 17	(1) 20% (2) 9-28 (3) Three

Did not use any magnification aid.

GROUP AV. 15%

Firearm and Toolmark Identification Criteria

E201

Instructors

AL BIASOTTI
JOHN MURDOCK

December 10-14, 1990

CALIFORNIA CRIMINALISTICS INSTITUTE

California Criminalistics Institute
Bureau of Forensic Services
California Department of Justice

CCI/E201 COURSE
(Apr 29 - May 3, 1991)

INSTRUCTOR COPY : STUDENT NOTE PKG for: (BIASOTTI)

PRACTICAL EXERCISE NO. 1

CHISEL, STRIATED TOOLMARK COMPARISON

STUDENT ASSIGNMENT OF TEST SETS

STA. #		STUDENT NAME & NUMBER DATE	TEST SET #
1	1	BARBER DAVE ~~CASSIDY~~, ~~Frank~~ DOJ/SB Lab	T-1 & T-2 of MK 1 to 4
	2	VIDERGAR, Donna San Bernardino S.O.	
2	3	CORAZZA, William DOJ/SX Lab	T-3 & T-4 of MK 1 to 4
	4	HINKLEY, Robert Alameda S.O.	
3	5	SAGGS, Michael DOJ/SC Lab	T-5 & T-6 of MK 1 to 4
	6	HIGASHI, Dale Los Angeles S.O.	
4	7	SHAM, Paul DOJ/RI Lab	T-7 & T-8 of MK 1 to 4
	8	NICHOLS, Ronald Oakland P.D.	
5	9	WOLBERG, Eugene San Diego P.D.	T-9 & T-10 of MK 1 to 4
	10	SACHS, STARR Los Angeles P.D.	
6	11	PETERSON, Edward Santa Clara County Lab	T-11 & T-12 of MK 1 to 4
	12	ARASE, Gerald Sacramento County Lab	

CCI/EE201 APR. 30 1991

PRACT. EXER No 1, CHISEL MARK COMPAR.

INSTRUCTOR COPY!
(BLACK)

Work Station 6

M. PETERSON, ED
12. ARASE, GERARD.

STRIAE COMPARISONS – TOOLMARKS
EXAMINATION FORM / WORKSHEET

STA. No. 6

TOOLMARK TYPE: Chisel EXAMINER: EP (PETERSON)

TOOLMARKS COMPARED		FREQUENCY: CONSECUTIVE MATCHING STRIAE (RUN LENGTHS)				
LEFT	RIGHT	(1)	(2)	(3)	(4) or HIGHER (x)	DATE & TIME
(RG-1) S-1 T-11 ~~total lines~~ XTSC/WDTH.	(RG-1) S-1 T-12	~~TOT~~ total line count ① 36	~~TOT~~ total line count ② 49	total line count ③ 51	~~TOTAL~~ total line count ④ 43	X TSC = 45 Photos 1 & 2 4/30/91
(RG-1) S-1 T-11 out of phase position 1	(RG-1) S-1 T-12	1 (5)	1 (1)	1 (1)	0 (0)	5/45 = 11%
(RG-1) S-1 T-11 out of phase position 2	(RG-1) S-1 T-12	IIII (4)	0 (0)	0 (0)	0 (0)	4/45 = 9%
(RG-1) S-1 T-11 out of phase position 3	(RG-1) S-1 T-12	IIII 1 6	0 (0)	0 (0)	0 (0)	6/45 = 13%
(RG-1) S-1 T-11 out of phase position 4	(RG-1) S-1 T-12	IIII 5	0 (0)	0 (0)	0 (0)	5/45 = 11%
(RG-1) S-1 T-11 out of phase position 4	(RG-1) S-1 T-12	1 1	0 (0)	0 (0)	0 (0)	1/45 = 2%

SUMMARY: $\bar{X}$ % MATCH =

RANGE $\bar{X}$ % MATCH = 2 to 13%

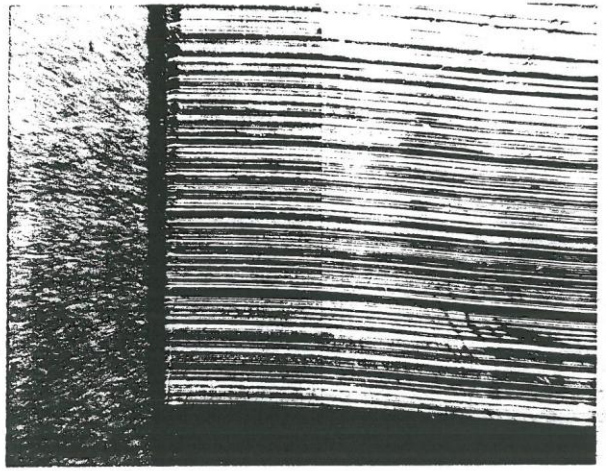
HIGHEST RUN COUNT = 3

Toolmark Type: Chisel

STM 6

Examiner: ED

1



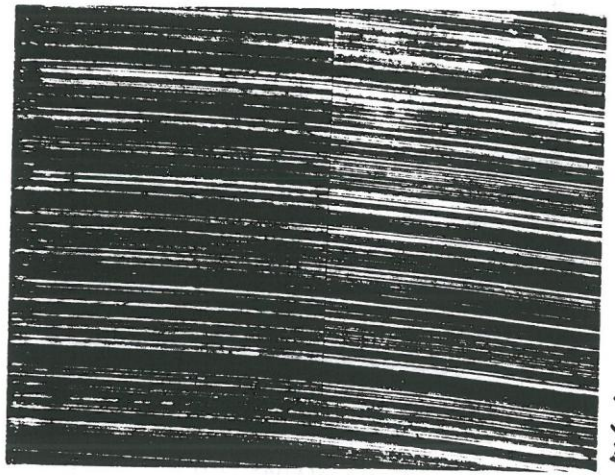
5.3 mm

2.00

1X

(RG-1) S-4, T-11 (RG-1) S-4, T-12

2



8 mm

2.00

1X (2x)

(RG-1) S-4 T-11 (RG-1) S-4, T-12

CCI/B201 APR 29 → MAY 3, 1991

PRACTICAL EXERCISE #1 CHESIC MARCIC COMPARISONS

4/30/91, 1600 HOURS, TABULATION AND DISCUSSION OF RESULTS –

SUMMARY OF STRIAE COUNTING FOR 12 STUDENTS :

(1) MEAN TOTAL STRIAE COUNT ($\bar{x}$ TSC) RANGE :
∴ 24 to 66 STRIAE 2x(4-20) RIPLD

(2) RANGE of % MATCH : 4 to 38 %

(3) HIGHEST RUN COUNT = only two quotable "3" run counts

STRAIE COMPARISONS – TOOLMARKS
EXAMINATION FORM / WORKSHEET

TOOLMARK TYPE:

EXAMINER: CLASS SUMMARY 4/30/91

TOOLMARKS COMPARED		FREQUENCY: CONSECUTIVE MATCHING STRAIE (RUN LENGTHS)				
LEFT	RIGHT	(1)	(2)	(3)	(4) or HIGHER (x)	DATE & TIME
$\bar{X}$ TSC/WDTH.						
12 STUDENTS:						
$\bar{X}$ TSC RANGE			24 → 6C			
		RANGE $\bar{X}$ % MATCH 4 → 38%				
		HIGHEST RUN COUNT = 3?				

SUMMARY: $\bar{X}$ % MATCH =

RANGE $\bar{X}$ % MATCH =

HIGHEST RUN COUNT =

PE #2

CCI/E201 Course

BULLET COMPARISON TEST SETS FROM S&W 38 SPL.

SEQUENTIALLY RIFLED BARRELS #1 TO 10 (1980)

Step-broached

Test Set	Ammo Type	BBL #	Test #	BBL #	Test #	BBL #	Test #	BBL #	Test #	BBL #	Test #
1	Lead	1 2	1, 2, 3 1, 2, 3	3 4	" "	5 6	" "	7 8	" "	9 10	" "
	JSP	1 2	4, 5, 6 4, 5, 6	3 4	" "	5 6	" "	7 8	" "	9 10	" "
(2) MISSING SET	Lead	1 2	7, 8, 9 7, 8, 9	3 4	" "	5 6	" "	7 8	" "	9 10	" "
	JSP	1 2	10,11,12 10,11,12	3 4	" "	5 6	" "	7 8	" "	9 10	" "
3	Lead	1 2	13,14,15 13,14,15	3 4	" "	5 6	" "	7 8	" "	9 10	" "
	JSP	1 2	16,17,18 16,17,18	3 4	" "	5 6	" "	7 8	" "	9 10	" "
4	Lead	1 2	19,20,21 19,20,21	3 4	" "	5 6	" "	7 8	" "	9 10	" "
	JSP	1 2	22,23,24 22,23,24	3 4	" "	5 6	" "	7 8	" "	9 10	" "
5	Lead	1 2	25,26,27 25,26,27	3 4	" "	5 6	" "	7 8	" "	9 10	" "
	JSP	1 2	28,29,30 28,29,30	3 4	" "	5 6	" "	7 8	" "	9 10	" "

Test Identification Markings: each test bullet is scribed on the base with the BARREL # over the TEST # and with the SET # enclosed in a circle, i.e., 1/5 (4), etc.

PE #2

RNichols/Stn 4
1 May 91

STRIAE COMPARISONS OF FIRED BULLETS INFORMATION/EXAMINATION FORM

EXAMINER RNICHOLS DATE 1 MAY 91 LOCATION CCI

CASE/SAMPLE # TEST BULLETS, S+W, SAME BBL, SET 3

	CAL	- MOD. -	- MFG/MAKE -	- SR# -	- BBL. LGTH -	- LAG/TWT - LWD/GWD
F-(1)	38 SPL		S+W		4"	SR 100/100

RIFLING BROACHED BBL. COND NEW BBL. PREP NONE CAST NONE
MFG METH. BUTTON BURNISH

F-(1) _____

RIFLING _____ BBL. COND _____ BBL. PREP _____ CAST _____
MFG METH. _____

AMMUN. TYPE 38 SPL SLRN - 158 gr RECOV. MEDIA _____

INDEX COMPARED F- T- ( )	INDEX COMPARED F- T- ( )	RUN LENGTHS SET 3: LEAD BULLETS	TOTAL COUNT LEFT	TOTAL COUNT RIGHT	PHOTO MAGNIF.
BBL 6	BBL 6	BEST ID, SAME BBL, LI			
T13(L1)	T14(L1)	1, 1, 4, 1, 3, 5	26	24	2x(2+) 29x MAG
BB6	BBL 6	NON-IDENT, SAME BBL, LI			
T13(L1)	T14(L2)	1, 1, 1	26	12	
T13(L1)	T14(L3)	NR	26	7	
T13(L1)	T14(L4)	NR	26	9	
T13(L1)	T14(L5)	1, 1	26	9	
BBL 6	BBL 6	BEST ID, SAME BBL, GI			2x(2+) 29x MAG
T13(G3 2 1)	T14(G3 2 1)	2, 1, 6, 1, 2	26	37	
BBL 6	BBL 6				
T13(G3)	T14(G4)	1	26	13	
T13(G3)	T14(G5)	1, 1	26	22	
T13(G3)	T14(G1)	1, 1	26	24	
T13(G3)	T14(G2)	1, 1, 1	26	35	

RNichols/Stn 4
1 May 91

STRIAE COMPARISONS OF FIRED BULLETS
INFORMATION/EXAMINATION FORM

EXAMINER R NICHOLS DATE 1 MAY 91 LOCATION CCI

CASE/SAMPLE # S+W TEST BULLETS, SAME BBLS, SET 3

	CAL	- MOD. -	- MFG/MAKE -	- SR# -	- BBL. LGTH -	- LAG/TWT - LWD/GWD
F-(1)	38 SPL		S+W		4"	SR 100/100

RIFLING MFG METH. BROACHED BUTTON BURNISHED BBL. COND NEW BBL. PREP NONE CAST NONE

F-(1) _____

RIFLING MFG METH. _____ BBL. COND _____ BBL. PREP _____ CAST _____

AMMUN. TYPE 38 SPL JSP RECOV. MEDIA _____

INDEX F- T- ( )	COMPARED F- T- ( )	RUN LENGTHS SET 3 JSP	TOTAL COUNT LEFT	TOTAL COUNT RIGHT	PHOTO MAGNIF.
BBL 6	BBL 6	BEST ID; SAME BBL; L1			
T16(L1)	T17(L1)	2, 5, 2, 14, 3, 6	42	38	2x(2+) MAG x29
T16(L1)	T17(L2)	2, 1	42	17	
T16(L1)	T17(L3)	NR	42	31	
T16(L1)	T17(L4)	NR	42	35	
T16(L1)	T17(L5)	1, 1	42	40	
BBL 6	BBL 6	BEST ID; SAME BBL; G1			
T16(G1)	T17(G1)	2, 3, 2, 4, 2, 7, 2, 3	46	42	2x(2+) MAG x29
T16(G1)	T17(G2)	1, 2, 1	46	23	
T16(G1)	T17(G3)	1, 1	46	32	
T16(G1)	T17(G4)	1, 1	46	32	
T16(G1)	T17(G5)	1, 1, 2(2)? second "2" questionable - short marks at base - slightly corked	46	34	

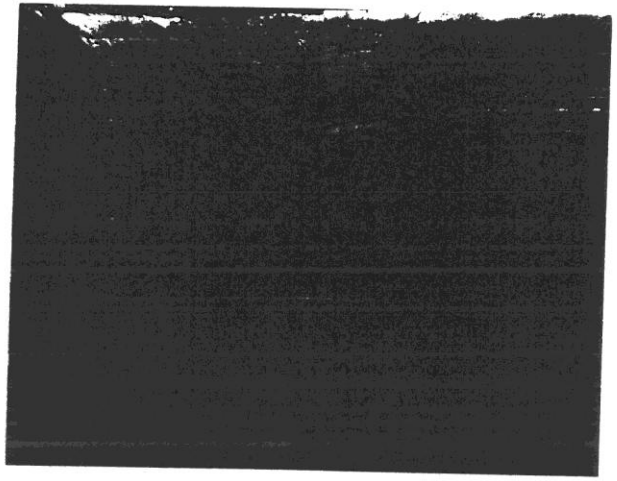
PE #2

Worksheet #2
RNichols / Stn 4
1 May 91

4/11

Practical Exercise #2

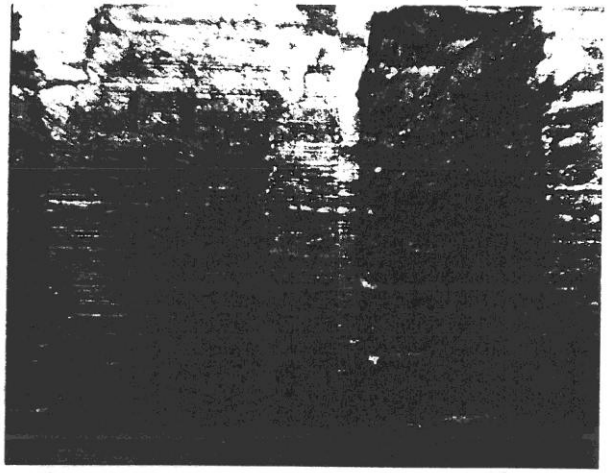
38 SPL BBL #6 T13(G3)/BBL #7 T13(G1) LEAD



Diff (consecutive)
bbls -
#6(T13/G3)
#7(T13/G1)

2x(2v) MAG 29x 2.0 5.0 min NICHOLS

38 SPL BBL #6 (T13/G2)/BBL #7 (T13/G5) LEAD



Consecutive Bbls
#6(T13/G2)
#7(T13/G5)

2x(2v) MAG 29x 2.0 6.4 min NICHOLS

CET/E201 May 3 1991

PRACT. EXER. NO. 5

30 CAL BUTTON BARREL BLANKS

STUDENT NOTES

STA. NO (4) { (7) SIMMS, PAUL
(8) NICHOLS, RON

PRACTICAL EXERCISE #5 Worksheet #1 1/3

STRIAE COMPARISONS OF FIRED BULLETS INFORMATION/EXAMINATION FORM

EXAMINER R NICHOLS / STATION 4 DATE 3 MAY 91 LOCATION CCI

CASE/SAMPLE # .30 CAL BUTTON RIFLED BARREL BLANKS - CONSEC BBLS #1 AND #2

CAL - MOD. - - MFG/MAKE - - SR# - - BBL. LGTH - - LAG/TWT - LWD/GWD

F-(1) _____

RIFLING MFG METH. BUTTON BBL. COND NEW BBL. PREP NONE CAST MIKROSIL BEFORE

F-(1) _____

RIFLING MFG METH. _____ BBL. COND _____ BBL. PREP _____ CAST _____

AMMUN. TYPE .30 CAL FMJ RECOV. MEDIA _____

INDEX F- T- ( )	COMPARED F- T- ( )	RUN LENGTHS	TOTAL COUNT LEFT	TOTAL COUNT RIGHT	PHOTO MAGNIF.
BBL 1	BBL 2	SEQUENTIAL BBLS			
T1-5	T2-7				
T1-5 (G12)	T2-7 (G14)	1, 2, 1, 2			2× (14× MAG)
T1-5 (G3)	(G5)	2, 1			2×(2+) 29× MAG
(G4)	(G6)	AXIAL ONLY ON T2-7			
(G5)	(G1)	AXIAL ONLY ON T2-7			
(G6)	(G2)	2, 4 (LIBERAL 4 - DEFINITE 3)			2×(2+) MAG 29×
(G1)	(G3)	1, 2, 1, 1			TRI-X @ 12 - 10.0 min EXP
T1-5 (L1)	T1-5 (L3)	1			
(L2)	(L4)	1, 2			
(L3)	(L5)	NR			
(L4)	(L6)	NR			
(L5)	(L1)	NR			
(L6)	(L2)	1, 1			

*NOTE: (2) TEST FIRES FROM BBL 1 EASILY PHASED AND MATCHED

State of California

Department of Justice

Memorandum

To : STUDENTS, E201 COURSE
Apr 29 - May 3, 1991

Date : June 21, 1991

Telephone : (916) 739-4380
ATSS 497-4380

From : Al Biasotti
AL BIASOTTI
Bureau of Forensic Services
California Criminalistics Institute

Subject : **CONTACT PRINTS OF TRI-X NEGS., BULLET STRIAE COMPARISON EXERCISES**

Enclosed for your file are 11 contact prints from the Tri-X Negs taken by the entire class. Neg #4 was not exposed; and Neg #5 and 7 are repeats of Neg #6 and 8 repsectively, which were not printed.

These 11 prints represent the best "known non-matches" found by the entire class for all the practical bullet striae comparison.

Neg # 3, 6, & 8 are the subclass characteristics noted in a limited number of groove impressions on lead tests from the 10 sequentially rifled S&W, 38 Spl, revolver barrels (practical exercise #2). Without having the barrels, or casts to examine, the reason why these remarkable subclass characteristics occurred cannot be fully explained. However, based on the limited extent of the similarities noted by both E201 classes and my personal observations, it can be concluded that the similarities noted represent an extremely rare event that would not be expected to be encountered in actual case situations. The rationale for this conclusion is:

1. The degree of correspndence shown in Negs # 1, 3, 6, and 8 occurred in groove impressions of lead tests only.

2. This correspondence started with Barrel #4 and ended at Barrel #7.

3. This correspondence is limited to lead bullets from test set #1 (T, 1-3) and test set #3 (T, 13-15). Test set #2 is missing and was not studies.

The most important lesson to be learned from all of the striated toolmark/ bullet comparisons exercises are:

1. That the chance occurrence of more than 3 or 4 consecutively corresponding striae is an extremely rare event, rising expodentially with an increasing combinations of 2 or more consecutively corresponding striae. Therefore, the concept of consecutive striae is the most effective criteria for determining common origin of toolmarks.

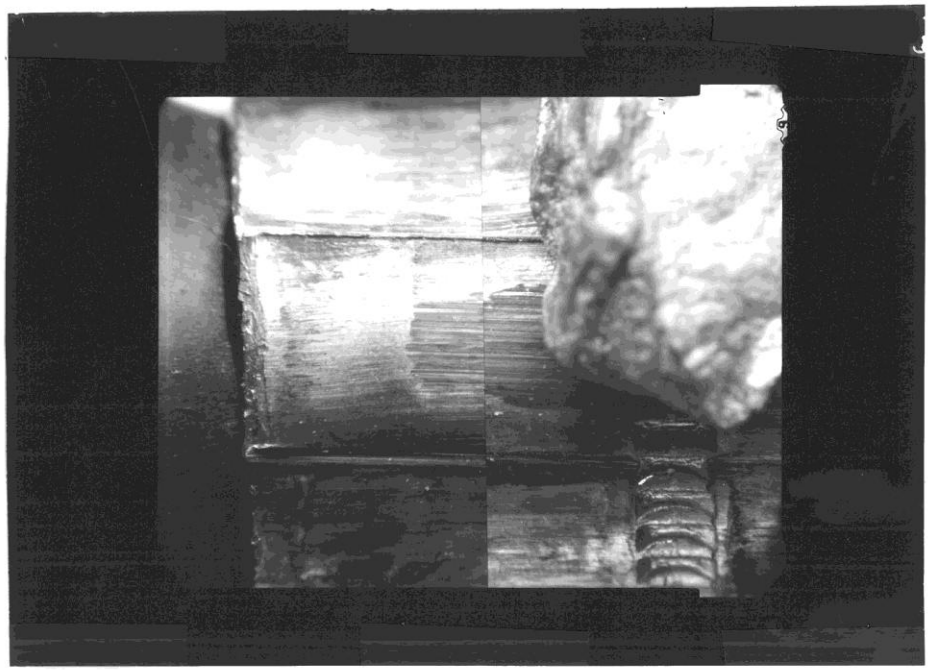
2. That the occurence of subclass characteristics in rifled firearms barrels is a rare event that can be easily determined by the direct inspection of the rifling or a barrel cast; and where the barrel or barrel cast is not available, by applying a more consecutive criteria in determining common origin.

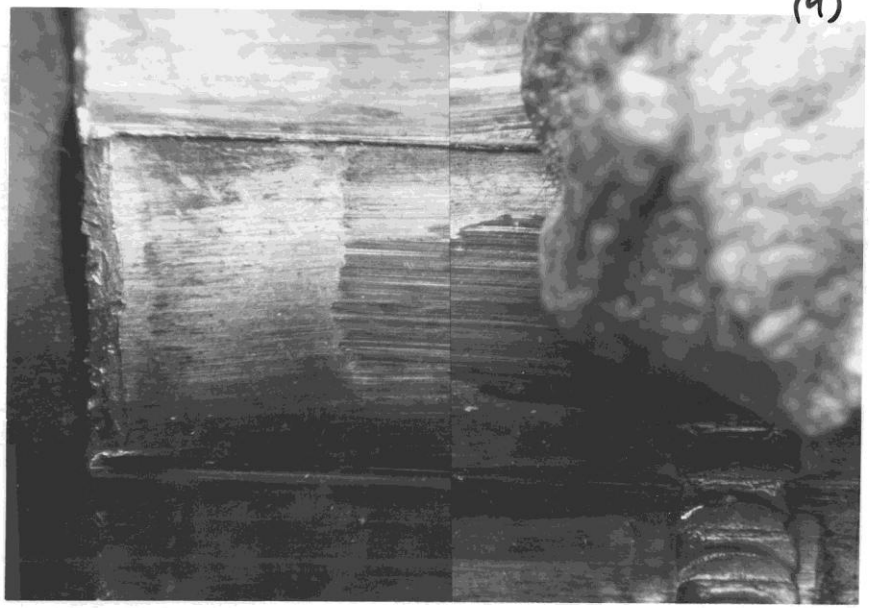
Identification of Tri-X Negatives Taken by Students:

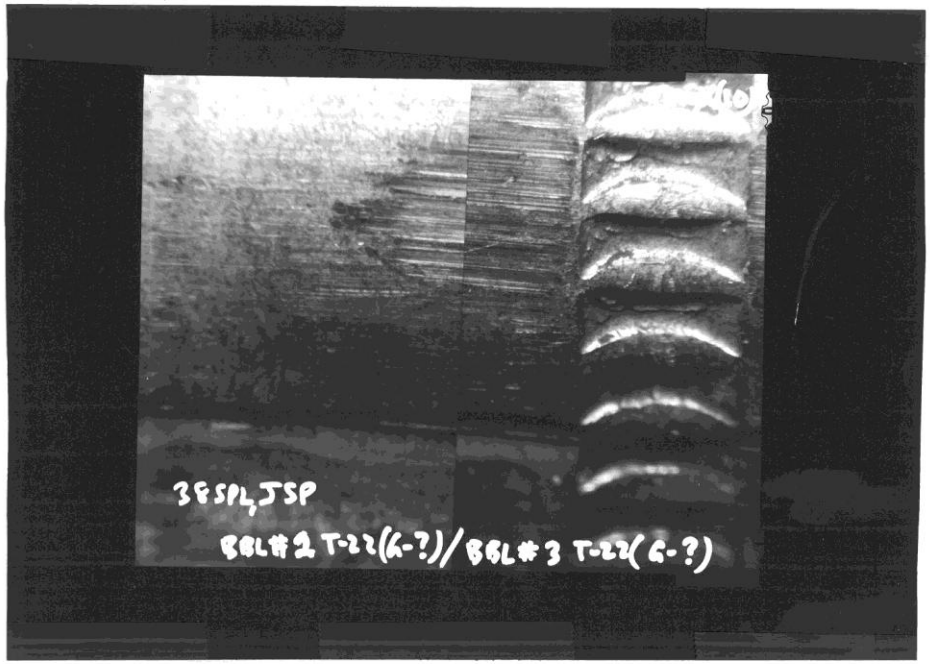
TRI-X #	STA. #	Subject	Tests Compared	Polaroid Print on Wall Chart
(1)	4	38 Spl, S&W, Lead	BBL #6, T-13 (G-3)/BBL #7, T-13 (G-1)	Y
(2)	4	38 Spl, S&W, JSP	BBL #6, T-16 (G-1)/BBL #7, T-18 (G-4)	
(3)	1	38 Spl, S&W, Lead	BBL #4, T-3 (G-5)/BBL #5, T-3 (G-5)	Y
(4)	B L A N K N O T E X P O S E D			
(5)	2	38 Spl, S&W, Lead not printed, see (6)	BBL #6, T-2 (G-3)/BBL #7, T-2 (G-1)	Y
(6)	2	Repeat (5) with "new" A.O. Fluor. Illum.		
(7)	2	38 Spl, S&W, Lead not printed, see (8)	BBL #5, T-1 (G-4)/BBL #6, T-2 (G-3)	Y
(8)	2	Repeat (7) Same		
(9)		Can not identif from notes, appears to be 38 Spl, S&W, JSP; Groove, at 2X w/o doubler		
(10)	5	38 Spl, S&W, JSP	BBL #2, T-22 (G-?)/BBL #3, T-22 (G-?)	
(11)	1	GLOCK "A" 9mm	A, T-1 (L-1)/A, T-2 (L-2)	
(12)	4	30 Cal. Button BBL	BBL #1, T-1-5, (G-6)/BBL #2, T-2-7, (G-2)	
(13)	2	GLOCK "A" 9mm	A, T-10 (L-1)/A, T-11 (L-4)	
(14)	2	GLOCK "A" 9mm	A, T-10 (L-1)/A, T-11 (L-5)	

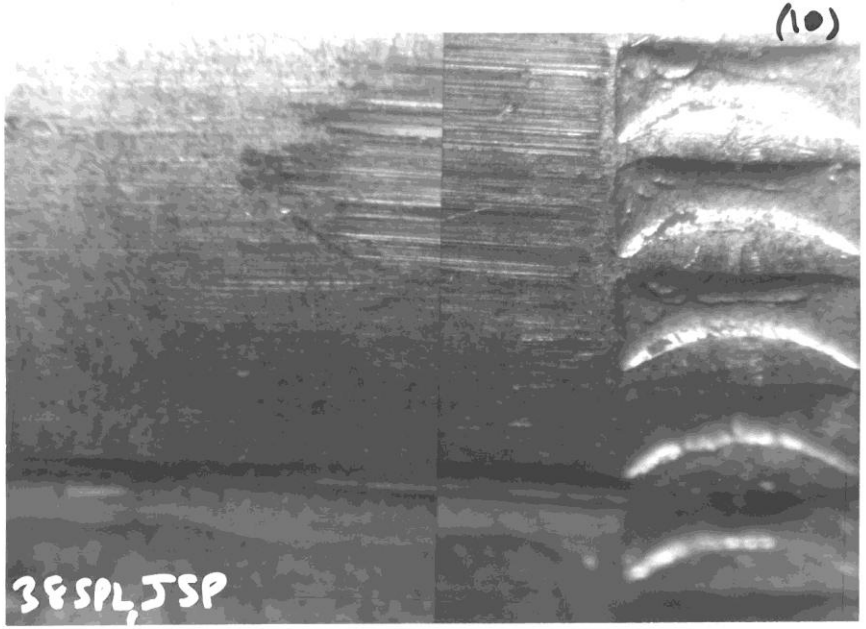
Enlargements of Tri-X, 4 X 5 Negs. to 5 X 7 Prints
(Total of 11 Negs., 3 prints each neg.)

#	Neg #	Subject	Identification of Subject
1	(1)	38 Spl, S&W, Lead	BBL #6, T-13 (G-3)/BBL #7, T-13 (G-1)
2	(3)	38 Spl, S&W, Lead	BBL #4, T-3 (G-5)/BBL #5, T-3 (G-5)
3	(6)	38 Spl, S&W, Lead	BBL #6, T-2 (G-3)/BBL #7, T-2 (G-1)
4	(8)	38 Spl, S&W, Lead	BBL #6, T-1 (G-4)/BBL #6, T-2 (G-3)
5	(2)	38 Spl, S&W, JSP	BBL #6, T-16 (G-1)/BBL #7, T-18 (G-4)
6	(9)	38 Spl, S&W, JSP	N O T I D E N T I F I E D
7	(10)	38 SPl, S&W, JSP	BBL #2, T-22 (G-?)/BBL #3, T-22 (G-?)
8	(11)	GLOCK, 9mm RMC	A, T-1 (L-1)/A, T-2 (L-2)
9	(13)	GLOCK, 9mm RMC	A, T-10 (L-1)A, T-11 (L-4)
10	(14)	GLOCK, 9mm RMC	A, T-10 (L-1)/A, T-11 (L-5)
11	(12)	.30 Cal., RMC	BBL #1, T-1-5, (G-6)/BBL #2, T-2-7(G-2)




(9)


3FSPL,JSP
B&L#2 T-22(G-?)/B&L#3 T-22(G-?)


(10)
3FSPL,JSP

The conclusions drawn from this training and research were published in 1997 in a chapter entitled "Firearms and Toolmark Identification" by Biasotti and Murdock which appeared in the two volume set "Modern Scientific Evidence – The Law and Science of Expert Testimony". The author's conservative quantitative criteria for identification are:

1. In three dimensional toolmarks when at least two different groups of at least three consecutive matching striae appear in the same relative position, or one group of six consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark.
2. In two dimensional toolmarks when at least two groups of at least five consecutive matching striae appear in the same relative position, or one group of eight consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark. For either of these criteria to apply, however, the possibility of subclass characteristics must be ruled out.

These same conclusions appear, unchanged, in Chapter 35, now authored by Biasotti, Murdock and Moran, in the now five volume set of Modern Scientific Evidence (MSE) published 2009-2010.

SCIENTIFICALLY DEFENSIBLE CRITERIA FOR THE IDENTIFICATION OF STRIATED TOOLMARKS WORKSHOP

COURSE DESCRIPTION: This 2 ½ day (20 hour) course will provide students with a review of the concepts and rationale of identifying striated and non-striated impression evidence. Recent challenges and relevant court decisions will be discussed. Each student will verify their rational, objective basis for making such identifications. Although new examiners can profit from this training, this course is designed for firearm and toolmark examiners who have had training in the comparison of striated toolmarks and at least one year of actually comparing toolmarks. This class is limited to 40 students.

INSTRUCTORS: John Murdock, Contra Costa County Sheriff's Office and Bruce Moran, Sacramento County District Attorney's Office

TEACHING METHODS: Classroom lectures, demonstrations, group discussions, and practical laboratory exercises.

STUDENT OBJECTIVES: Students will be required to complete a series of practical exercises, and to explain the related concepts of toolmark identification and their rationale for the identification to the satisfaction of the instructors.

PREREQUISITES: Must have been performing striated toolmark comparisons in case work for at least a year and be familiar with accepted standards of casework documentation and common equipment and terminology used in that discipline.

PREPARATION: Pre-course reading material will be assigned.

SINCE 2003, THE FOLLOWING CRITERIA FOR ID WORKSHOPS, OF VARYING LENGTH, HAVE BEEN PRESENTED:

1) at Annual AFTE training seminar – May 2003 – Philadelphia, PA (8 hours) – 25 students; 2) at Annual AFTE training seminar – May 2004 – Vancouver, BC (12 hours). 25 students; 3) at Annual AFTE training seminar – June 2005 – Indianapolis, IN (12 hours and 40 students); 4) at International Association of Forensic Sciences tri-annual meeting in Hong Kong, China – 13 hours – 25 students, August 25 – 26 2005; 5) at Los Angeles Police Department for all LAPD FA/TM Examiners, 16 hours, October 15 - 16, 2005; 6) at the Annual AFTE training seminar in San Francisco, CA, June 7, 2007 -15 hours - 33 students; 7) in Bad Camberg, Germany for 50 students from over 20 European Countries, 20 hours – March 2009; 8) in Albany, NY for the New York State Division of Criminal Justice Services -18 students - 20 hours; 9) in Sacramento, CA for California Dept. of Justice, California Criminalistics Institute (CCI), – Nov 16 – 18, 2010 – 20 hours – 25 students; 10) in Los Angeles, CA for California Dept. of Justice, California Criminalistics Institute (CCI), April 2011, 12 students – 20 hours; 11) at Annual AFTE training seminar in Chicago, IL – 8 hours – 30 students; and 12) for the Los Angeles Police Dept., Sept 27 – 29, 2011 – 25 students. TOTAL: approximately 328 Students