Letters to the Editor

Discussion of "The Desirability of a Ph.D. Program in Forensic Science"

Dear Sir:

The article by Kobilinsky and Sheehan "The Desirability of a Ph.D. Program in Forensic Science" (Vol. 29, No. 3, July 1984, pp. 706–710) in the *Journal* is of considerable interest. The problems relating to training and education in the forensic sciences are of importance to all of us. Unfortunately, two aspects of this discussion perpetuate a point of view which is misleading and/or inappropriate.

Perhaps, understandably, criminalists seem reluctant to use the term "criminalistics" to describe their professional activities. It is an awkward term, does not appear in most dictionaries, and communicates poorly to the general public. As a result, advanced degree programs in "forensic science" are being considered, or even offered, by some schools. In my view, one can no more offer a Ph.D. degreee in forensic science than a Ph.D. degree in general science. Is it really possible for one individual to master forensic pathology, forensic psychiatry, and all the other forensic specialties, to the extent implied by a Ph.D. degree? Further, this runs the risk of developing a forensic "expert" who would be accepted by courts and give opinions in any of the forensic specialties. At least the public may perceive a doctor of forensic science to be so qualified.

A second problem is the use of a Ph.D. degree program as a model for the proposed advanced training. There is some variation from institution to institution, of course, but generally Ph.D. training is a scholarly exercise during which a student must not only demonstrate considerable depth of knowledge in a specific area, but the ability to use this knowledge in creative, innovative, and independent ways. I agree with Kobilinsky and Sheehan in their conclusion that forensic science would benefit greatly from the input of Ph.D. level personnel. I am somewhat skeptical however, that a Ph.D. program necessarily prepares individuals for research, teaching, and administration. There are other attributes and skills necessary to develop individuals for these tasks, in addition to graduate training.

As the authors describe the areas of training to be covered (some 20 to 30 specific areas) including the value of practical experience in the crime laboratory, it seems that another model would be more appropriate: a professional degree. This post-baccalaureate training can include general training but also provides the opportunity to specialize, conduct research, and so forth. There are many fields presently using this approach (medicine, engineering, medical technology) that can demonstrate strengths in one or more aspects for training criminalists.

Five years ago, Ellis R. Kerley chaired a Forensic Science Educator's Committee that made recommendations to Law Enforcement Assistance Administration (LEAA) relative to training and education in the forensic sciences. Although political changes negated this effort, many of us had an opportunity to air our views. Kobilinsky and Sheehan now raise some of these issues again. This is welcome. But my plea is to avoid the implication that criminalistics includes all of the forensic sciences. In addition, it appears that post-baccalaureate training other than Ph.D. programs will serve as more appropriate models.

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Author's Response

Dear Sir:

We do not agree with Dr. Blanke that "criminalists seem reluctant to use the term 'criminalistics' to describe their professional activities." While it may be true that it is "an awkward term . . . [which] communicates poorly with the general public," this same criticism could also be leveled at the term "forensic science" and its abominable variation "forensics," which we see gaining increasing use. We must not be tempted to conclude that scientists in this field have not considered the scope of their field and the best term to use to describe it. Many thoughtful criminalists in this country have long wrestled with the term "criminalistics" and its meaning. Certainly most agree that it is a very broad field, although perceptions regarding the exact scope of the field vary in different parts of the world. However, no one claims that ". . . criminalistics includes all of the forensic sciences."

One of the reasons that many academic programs call themselves forensic science programs is that they hope to address themselves to a limited number of specialties in forensic science that most would agree fall outside the purview of criminalistics, such as forensic toxicology or questioned document examination.

The question of program titles was discussed in a 1977 paper by Peterson and De Forest [*1*]. Hopefully, no program naively attempts to turn out a graduate that has in-depth expertise in all the many aspects of forensic science and we certainly do not propose this. We agree that it would be impossible for one individual to master all the forensic specialties, such as pathology, toxicology, and so forth. We disagree that this is implied by a Ph.D. degree. Does a Ph.D. chemist have a mastery of physical chemistry, analytical chemistry, organic chemistry, biochemistry, immunochemistry, nuclear chemistry, and all of the many other chemical sciences? The Ph.D. chemist may have been exposed to some of these fields during his experiences as a student or during his professional career but certainly nobody would believe him to be an expert in all of these fields.

The problem of the "expert" who crosses disciplinary boundaries in offering testimony in a myriad of areas predates forensic science programs. The institution of such programs combined with maturation of the field is one of the best ways of countering this problem and we disagree that an individual with a Ph.D. in forensic science would be accepted by courts as an expert in all of the forensic specialties. We do not believe that a recipient of a Ph.D. in forensic science who is trained in and practicing drug chemistry would be considered an expert witness in the field of serology where he had little or no training. The "voir dire" of the witness provides the opposing attorney the opportunity to question and challenge the expert's qualifications. It is not the jury but the judge who must be satisfied with the expert's credentials and qualifications, so it is, in fact, irrelevant if "the public may perceive a doctor of forensic science to be so qualified."

The opinion that our proposal is a rehashing of ideas that had been developed during the work of the committee of educators [*2*], referred to in Dr. Blanke's letter, is not shared by us or our colleague, Dr. Peter De Forest, who was a member of that committee. It is unfortunate that the work of the committee was not continued. We agree with Dr. Blanke that more attention needs to be given to forensic science education and to the means of fostering the exchange of ideas relative to forensic science education. For a number of years in the late 1970s forensic science educators and concerned forensic scientists met at the annual meeting of the Academy to discuss issues relating to forensic science education. At the latest meeting of the International Assocation of Forensic Sciences in Oxford, one session was devoted to problems in forensic science education. Such meetings, while helpful, are too short and infrequent and are not adequate for a full airing of views.

It is our view that a good Ph.D. program should prepare an individual to perform innovative research and generally does so by providing the student with the knowledge, insight, and tools to do so. Such programs will also provide students with teaching experience and provide him/

her with constructive criticism so as to improve communicative skills. A course in laboratory administration would be an important part of the curriculum for students wishing to enter administrative positions. We agree that there are other ways in which to train individuals in these areas and we did not mean to imply that graduate education is the only way; however, in our opinion, the training of individuals to perform research, to use their skills in a creative way, to expand our knowledge, and to develop new techniques and new ways of problem solving, can best be achieved through a Ph.D. program in forensic science.

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References

[1] Peterson, J. L. and De Forest, P. R., "The Status of Forensic Science Degree Programs in the United States," *Journal of Forensic Sciences*, Vol. 22, No. 1, Jan. 1977, pp. 17-33.
[2] Silvergleit, I. T. and Kerley, E. R., "Development of Forensic Science Higher Education Guidelines, Final Report," The Forensic Sciences Foundation, Rockville, MD, May 1980.

Discussion of "Electrocution by Street Lighting"

Sir:

The article that described five electrocutions (four were fatal) by street lighting needs some comments [1]. It is regrettable that many details of the electrocution were not given. In particular, the actual faults that lead to the electrocutions were not discussed. Finding the electrical fault that results in an electrocution is difficult when the electrical system is complex, particularly if the fault is of intermittent nature. However, for the cases under consideration, the electrical system was simple since they involved only the wiring in street lighting.

It seems clear that electrocution took place because the light pole was electrified. One live conductor came into electrical contact with the pole. The contact could be a metallic one such as physical contact between a wire and the pole or it could be from a leakage current through deteriorated insulation or by surface conduction on a polluted insulator. In this letter some of the underlying principles will be discussed.

Figure 1 shows a circuit that is used for feeding the light in the pole. A two-wire system connects the light to the transformer through a fuse. The pole is shown as a dotted line and is grounded through its base and a grounding conductor. Figure 2 shows the same situation as in Fig. 1 except that the ground wire is removed either because it was not installed or was broken. Most of the low-voltage electrocutions that this author has investigated were of the nature that is depicted in Fig. 2. The experience of other investigators points in the same direction [2-6].

With reference to Fig. 1, the live conductor is at a voltage V above ground and carries the current to the load. The current is brought back to the source through a neutral wire that is grounded. This conductor is also called the "grounded wire." A third conductor which is called the "ground wire" serves to ground the pole or the enclosure of an electric appliance. This conductor in house wiring or appliance is either bare or has a green insulating material. In a wall outlet or a plug, this ground wire corresponds to the round terminal in American homes. This ground conductor is not supposed to carry any current under normal conditions. Its purpose is to assure that the metallic enclosure is always at ground potential even in the event of a fault.

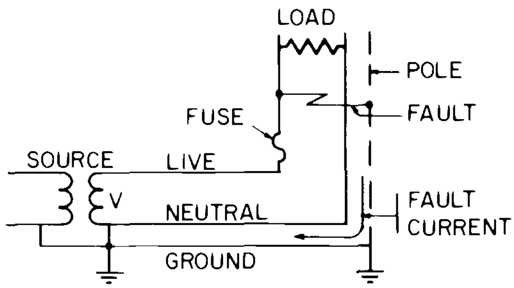

FIG. 1—*A system with a ground conductor.*

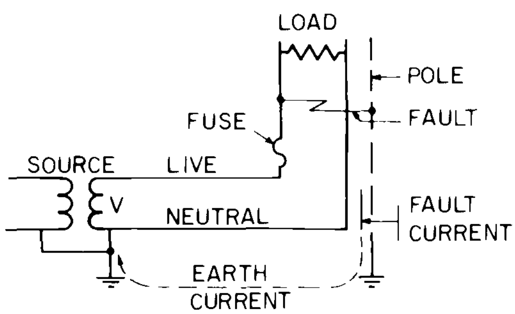

FIG. 2—*Fault current in earth because of the missing ground conductor.*

Let us assume that the live conductor comes in contact with the closure for some reason, such as an insulation failure. This constitutes a short circuit and a high current circulates through the live and ground wires. The fuse opens the circuit quickly. The potential of the pole or the enclosure reaches a voltage which is a small fraction of the source voltage *V*. That voltage lasts for a very small time until the fuse opens the circuit. The system is safe and good protection is assured against ground faults.

If the same fault occurs under conditions depicted in Fig. 2, the current returns to the source through the grounded pole and the earth to the grounded side of the source. The situation depicted in Fig. 2 may seem similar to that of Fig. 1. One may also be lead into false security since the pole is grounded through its concrete base with reinforced steel rod or a ground rod imbedded in the earth. However, this system is not safe. The resistance of the ground is quite high and has any value between a few tens ohms to perhaps a few thousands ohms. The actual value is dependent on the geometry of the ground rod, the nature and humidity content of the earth, and the temperature. A ground resistance of about 100 Ω should be considered typical of the situation since the earth was protected by a pavement and probably the soil was drained.

With a source voltage of 480 V as in the reported cases, the fault current is only 4.8 A. This will not blow the 10-A fuse and the pole will be at a voltage very close to 480 V. This is an extremely dangerous situation for anyone that touches both the pole and surrounding earth. One can even be electrocuted by walking around the pole since there will be a voltage gradient in the ground around the pole. A fuse cannot protect against electrocution in such cases since the lethal current is about 0.1 A [*4-8*]. A ground fault interrupter is however very effective since it assures that the circuit is interrupted in the advent of a ground current of the order of 0.005 A [*9*].

The behavior of a real ground electrode and its resistance is very difficult to predict. However, the case of a half sphere buried in the earth is quite simple to analyze. It is enlightening to consider that case since it provides insight into the problem.

Let us consider a ground electrode as in Fig. 3 where a half sphere radius a (m) is imbedded in a soil of resistivity ρ in $\Omega \cdot$m. It is intended to find the resistance between this half sphere and another one of radius b. A differential element of resistance is define at a radius r and of thickness dr. The resistance of that elementary shell is given by

$$dR = \frac{\rho dr}{2\pi r^2} \tag{1}$$

Integrating between limits a and b gives

$$R = \frac{\rho}{2\pi}\left[\frac{1}{a} - \frac{1}{b}\right] = \frac{\rho}{2\pi a}\left[1 - \frac{a}{b}\right] \tag{2}$$

If $b \to \infty$, one obtains

$$R_a = \frac{\rho}{2\pi a} \tag{3}$$

This is the resistance of the ground. The resistance of a ground is defined as the resistance between the electrode and another one at an infinite distance which is infinitely large.

Equations 2 and 3 show that a ground resistance has a finite value. Typical values for ρ range from 30 $\Omega \cdot$m in the case of marshy ground to over 1000 for dry sand and gravel [*10*]. Assuming that $\rho = 300\ \Omega \cdot$m and that $a = 0.5$ m, the ground resistance is 95.5 Ω. In the case of a ground fault at 480 V, the ground current is 5.03 A. This current is unsufficient to operate most fuses.

Figure 3 shows an equivalent circuit for the resistance of ground. From $r = a$ to r, the resistance is R_{ar}. From $r = r$ to ∞, the resistance is $R_{r\infty}$. Clearly, $R_{ar} + R_{r\infty} = R_a$. The potential on the ground is V at the half sphere, and 0 at infinity. The potential at a distance r is given by

$$V_r = \frac{VR_{r\infty}}{R_a} = \frac{V/2\pi r}{R_a} = V\frac{a}{r} \tag{4}$$

This shows that the potential decreases with the distance from the ground. A person who touches the ground rod and is standing at a large distance from the ground is subjected to a voltage V. If one touches the ground and is standing at a distance $r = a$, he receives a voltage of $V/2$.

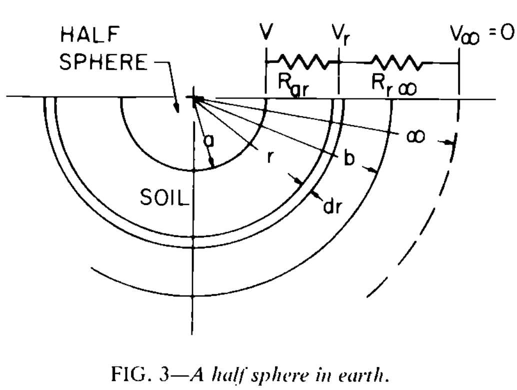

FIG. 3—*A half sphere in earth.*

The danger of electrocution is dependent on the current that circulates into the body. That current is a function of the applied voltage (or difference of potential) between two parts of the body. In the case under consideration, one who takes a step between distances r_1 and r_2 from the ground electrode is subjected to a voltage

$$V_{12} = \frac{Va}{r_1} - \frac{Va}{r_2} = Va\left(\frac{1}{r_1} - \frac{1}{r_2}\right) \tag{5}$$

For our example, if $r_1 = 2$ m, the voltage V_{12} is 120 V. Anyone who takes a step from 1 to 2 m from the ground is subjected to a voltage of 120 V.

Obviously, in practice, the actual potential distribution around the ground is dependent on the shape and dimensions of the electrode, the nonhomogeneous nature of the soil, and many other factors. Some of these factors are fixed once the electrode is chosen. Other factors depend on the water content of the soil and its temperature which could vary with time and from point to point in the soil. Although any real situation is extremely complex and not well-known, the above analysis shows the principles behind the problem of a ground fault current. This author is aware of many electrocutions (both humans and animals) that took place under the above conditions.

It is often thought that an enclosure is safe because it is grounded. A ground is safe only if its resistance is low enough so that the fuses are blown in the case of a ground fault. Most grounds are not good enough and one must rely on many of them that are connected in parallel and brought back to the grounded source as was shown in Fig. 1. This assures a high fault current that opens the protective device, even in the event of a poor ground.

It is hoped that this letter will clear some inaccuracies that were made in the article [*1*] concerning the high impedance ground (p. 838), the comments on the fusing (pp. 838 and 842), and ground fault (p. 839).

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[*8*] Dalziel, C. F., "Electric Shock Hazard," *Institute of Electrical and Electronics Engineers Spectrum*, Vol. 9, No. 2, Feb. 1972, pp. 41–50.

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[*10*] Roeper, R., *Short-Circuit Currents in Three-Phase Networks*, Pitman Publishing, London, 1972.

Author's Response

Dear Sir:

I have reviewed the comments on "Electrocution by Street Lighting" made by Bernard Béland. As I read the comment, I find a lucid and accurate summary of my paper with conclusions which agree with those stated by me. The major difference between Mr. Béland and myself is in the use of equations to estimate mathematically ground currents and resistances. The comments on ground fault interrupters and fusing, as made by Mr. Béland, I find accurate and in agreement with the conclusions in my own article.

I am grateful for this review and scientific summation of my own work and look forward to working together with Mr. Béland in an area of common interest.

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Discussion of "A Scientific Approach to Documenting Evidence for Accident Reconstruction"

Dear Sir:

The data and the photographs that the author of the above article (Vol. 29, No. 3, July 1984) suggests be collected and taken are well-founded and necessary. I would also suggest that two items be added to those presented.

First, given the innumerable physical features at the scene of an accident, and the uncertainty at times as to which are relevant, it often becomes imperative to take complete and proper photographic records of the location (for example, see paper by this writer, titled "Guidelines for Photographing High Locations Where Traffic Accidents Have Occurred," *Journal of Evidence Photography*, Vol. 12, No. 3, Spring 1984). Secondly, I suggest that at least a fifteenth and, as appropriate, a sixteenth (or more) camera angle be added to those identified for automobiles. The additional photograph, or photographs, should be taken from directly above or below (to the extent possible) the automobile.

These additions to the suggested data extend what I believe to be a well-founded presentation.

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Author's Response

Dear Sir:

I would like to thank Dr. Kuperstein for his kind remarks regarding my paper, they are much appreciated. Unfortunately I must disagree in part with his comments regarding a "complete and proper photographic record of the location." Indeed photographs must be taken of the scene of any accident but to consider them a *complete* record is a mistake. They can only assist the reconstructionist in documenting the scene. Even if the photographs were taken in a "true" perspective, measurements must be taken to allow the photogrammatist to do his work. The only "complete and proper record of any location" is to take measurements from a known reference point that can be located in the future through records of the utility companies or the local county governments. Photographs assist in only completing the "picture" (no pun intended). On p. 808 of my paper I clearly state that the investigator must take a picture of the reference point location.

In my check list I suggested that a *minimum* of 14 pictures be taken of the exterior of the vehicle. On p. 812 I have stated, "Check for undercarriage dents by having a tow truck lift the car up and take pictures of the underside components."

With so much information packed into my paper it is easy to see how these *finer points* can be overlooked.

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