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Theoretical Field Concepts in Forensic Science. I. Application to Recognition and Retrieval of Physical Evidence

Since the time when modern science was first used in a criminal investigation, its role in the judicial process has been accepted as being worthwhile. Today the call for expanded use of sceince in judicial processes is being increasingly raised by diverse necessities such as Supreme Court rulings restricting certain police practices and requiring independent corroboration of facts, official concern over rising crime rates, and society's view that technology, which has solved many complex problems involving human endeavor, can be successfully enlisted in the service of justice. However, recent expert opinion as well as several empirical studies have indicated that the role of scientific resources in judicial decision making is at best peripheral [*1–4*] and at worst inconsequential [*5,6*]. Though Parker [*7*] feels that "the problems of the proper utilization of physical evidence are poorly formulated at present, and there is a critical need for research on their solutions," several factors have been mentioned by forensic scientists and administrators to explain the meager scientific involvement in the justice system. Lack of funds, dearth of trained forensic science personnel, inadequate forensic science facilities, unavailability of forensic science laboratories in many areas, and other factors have been cited by administrators [*8*]. The reason usually given by the forensic scientists is the dearth of physical evidence submitted to the forensic science laboratories by the people engaged in field investigations because of their inadequate or superficial training in the recognition and collection of physical evidence [*9*] and the "lack of knowledge as to how the crime laboratory can aid the criminal investigator" [*10*]. To increase the flow of physical evidence into the laboratory by education of the police officer, field investigator, and the evidence technician a number of pamphlets, manuals, articles, and books have been written, courses have been offered in academic institutions, and lectures have been given on a regular basis in police academies to explain the importance of physical evidence and the proper procedures for its collection as well as the potentials and limitations of forensic science laboratories. This approach has been predicated on the assumption that forensic science is a coherent discipline based on clearly enunciated principles, well-defined and understood concepts, and agreed upon operational functions and goals. This, however, is not the case, as shown both by expert opinion and empirical evidence. In 1963, Kirk [*11*] stated that "there exists in the field of criminalistics a serious deficiency in basic theory and principles as contrasted with the large assortment of effective technical procedures." And six years later [*12*] he asserted:

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"There is no unanimity as to the true role of criminalistics and its directions," which Benson et al [*5*], a year later, found to be true in their attempt at a systems analysis of criminalistics operations. They found that "criminalistics has often had attributed to it a number of roles that are difficult to identify and quantify with available data" and that it was not possible to determine "what crime laboratories do, or more properly, what crime laboratories should do." These statements imply several points [*13*]:

1. Regarding the nature of forensic science, our assumptions are frequently implicit, sometimes quite unconscious, and perhaps often conflicting.
2. Without a properly defined objective, the value of this field to the judicial system in particular and to public policymaking in general will remain questionable, the development of remedial measures in terms of its involvement in the decision-making processes will remain uncertain, and the results of such an involvement will be unpredictable.
3. There is a pressing need to establish a workable theoretical foundation for this field. If such a theory were developed it would allow us to unify the field of forensic science and structure a discipline, define its aim and methods, and specify its role and place in public policy and decision making in judicial process. With this accomplished, it would be possible to derive its scope and specific procedures, clarify the educational and training requirements of its practitioners as well as its users, identify the areas of new research, develop operational stategies which would allow its proper implementation in public policy and judicial decision making, and provide an objective measure of its contributions or lack of them.

Obviously this undertaking cannot be completed in a single paper. This paper will therefore be limited to the promulgation of those concepts and premises from which the field of forensic science could be structured and unified. These concepts will then be applied to forensic science investigations to yield a unified approach to the recognition, documentation, collection, and preservation of physical evidence for examination, evaluation, and interpretation. In other words, this paper will deal largely with conceptual approaches to be used in the training and education of the field investigator who is expected to supply physical evidence to forensic science laboratories. Other topics mentioned earlier will be dealt with in a series of future papers.

Fundamental Principle

Assumptions

It is accepted, in science, that every event in nature is accompanied by changes or states in environment or space, and that these changes or states and the event are interrelated such that one can be inferred, explained, or identified from the knowledge of the other. This axiom underpins the general assumption and the experimental basis of all branches of science. The aim of scientific endeavor is to study the events and the changes or states in the environment to establish correlations or causal relationships between them.

This established general theoretical framework of science is taken as a model for the concept of forensic science. Forensic science will follow from the axiom and will be considered a special case of the general premise that applies to the study of interrelationships between human conduct considered suspicious or unlawful and the corresponding changes in space or environment.

Statement of Theory

The concept of relationships applied to forensic science can be stated in a general principle [*13*]:

> A criminal event, the human agent, and the environmental changes are interrelated, such that when one is known the others can be identified or inferred.

The general principle, as stated, yields two propositions. Proposition I is categorical and maintains that every criminal event is accompanied by changes in space or environment. Proposition II is conditional and holds that the knowledge of any one of the constituent terms given in the general principle permits the identification or inference of the other terms. These propositions and the general principle constitute a theoretical foundation of the discipline of forensic science from which this field can be unified and structured. For the present, the implications of the general principle to the retrieval of physical evidence are examined.

Application to Field Investigations

In the investigation of an unlawful or suspicious activity the collector of physical evidence must first recognize what must be collected. The traditional approach to the problem of recognition has been to supply would-be collectors with a list of common types of physical evidence such as blood, semen, saliva, documents, drugs, explosives, fibers, fingerprints, firearms and ammunition, glass, hair, impressions, organs and physiological fluids, and paint [*9*]; to inform them of the necessity of using common sense; and to give them some insight into the work of forensic scientists vis-a-vis identification, individualization, class, and individual characteristics [*10*] to induce proper handling and care of physical evidence during and after collection. This approach hardly answers the question of how to recognize which physical entities in a given situation should become the concern of the collector.

The capability to recognize relevant entities can only come about from an understanding of the basic nature of physical evidence.

Nature of Physical Evidence

The nature of physical evidence is given in the general assumption upon which the general principle, stated earlier, is based and is implicit in the general principle. Physical evidence is any change in physical environment (as space-energy-matter) that is brought about or associated with human criminal activity. Because every activity requires or entails expenditure of energy or force, physical evidence can be defined as spatial change resulting from energy effects in a given situation.

Recognition of Physical Evidence

Science has long recognized that perceived change in an entity is the result of alteration of some property of the entity (assuming the perceptive mechanisms are constant). The stage for recognition of physical evidence would be set by understanding what happens to an entity at some fundamental level when it undergoes a change. Because of energy effects, an entity undergoes a change in at least one of the following three fundamental ways. An entity may change in its space-time orientation. This is a change in the location of an entity with reference to the loaction of other entities; for example, when something is moved, removed, or introduced at a site. Change can also occur in the orientation of an entity's surface, that is, external features or internal structural units with reference to the original locations of its external/internal features. An example of the former change is a foot impression in mud which changes the original surface features of the mud patch. Congealing of blood where a rearrangement of the original molecular orientations has taken place exemplifies the latter type of change. In short, it may be said that no change in an entity is possible without an alteration in its location in space or reorientation of its external or internal features. It is not difficult to recognize that all conceivable changes that entities undergo are related to one or more of these changes in attributes.

Moreover, it should be recognized that the fundamental properties of location or external/internal features that are susceptible to alteration in every change limit the number of possibilities in which change in entities can be perceived by an observer. This provides a means for classification of change for identification purposes.

Because of energy effects changes in the external features take place when entities are dispersed, broken or torn, moved, impressed upon, and transferred. In some instances reorientation of structural units may change external features; for example, steel rusts. No other type of change that affects the orientation of external features is conceivable. Internal features are changed when transformed because of energy effects at the elemental or molecular levels. These are usually chemical reactions. These patterns of spatial reorientations, that is, changes in matter and energy caused by energy effects, include all possible changes and give the following classification as means of recognition and approach to physical evidence. It is to be remembered that physical evidence is defined as spatial change because of energy effects.

Classifications and Definitions

The following classifications and definitions are adopted from Ref *7*. The first category, extrinsic changes as physical evidence, includes these items:

(1) transfers—reallocation of matter/energy between two entities during or after contact is broken;
(2) impressions—imprint of one physical entity produced on another under pressure;
(3) dispersions—disintegration or scattering of entities or energy under force;
(4) breaks or tears—split of entities by force; and
(5) position—the time-space orientation of an entity as well as the locations of surface or internal features of entities (patterns are produced when positions are repeated).

The second category, intrinsic changes as physical evidence, includes transformations, which involve the reorientation of the internal structural units of entities. Implied in the definition is the intrinsic structure or the composition of physical entities.

Discussion

Classification of physical evidence in terms of the basic categories of physical changes provides several conceptual and operational advantages not presently available in an organized form to the collector of physical evidence.

First, the universe of physical evidence is unified. At a crime site the collector of physical evidence does not have to look for different individual items of physical evidence for different crimes. Search for all physical evidence has been reduced to a constant form of six basic categories of physical changes that are easily recognizable.

Second, the above change in perspective converts the search for individual physical entities to a search for possibilities, provides the framework for a thorough search, and limits the search to only the relevant areas of a site.

In practice the field investigator meets one of the two situations. At a crime site the investigator may perceive or be informed of physical objects related to the crime. In this instance, according to the above perspective, the investigator would approach these entities as carriers or causes of one or more basic categories of change. For example, a tool found in the possession of a burglary suspect would be approached as a possible carrier of transfers such as debris, fingerprints, paint, and glass and metallic particles; as break and tear in that part of the tool may have been broken; and as impression evidence in that it may carry an impression of the object upon which it was used. The tool would also be regarded as the possible cause of one or more basic categories of change such as an im-

pression of the tool left at the site where used, the transfer of metallic particles of the tool to the area where applied, and the break and tear of the site attacked with the tool. In terms of the spatial orientation of the tool the investigator would think in terms of the prior location of the tool and when it was brought to the crime sight.

By treating an entity as the carrier or cause of one or more categories of basic physical changes an investigation of all other entities and sites that are linked to it by virtue of these changes is necessitated. Consequently the search is limited only to those spatial points related to that entity. This results in a realistic sampling of the crime site. In the second instance, where specific physical entities related to a crime site are not perceptible, the search for physical evidence will be carried out in the context of the possible categories of changes that would correspond to that activity. This would lead to the discovery of specific physical entities that would then be approached as possible carriers or causes of physical changes.

Third, physical evidence approached in terms of possibilities provides a basis for the construction and verification of the activity. In an investigation it is essential to establish what took place during an activity and the link to events before and after the activity. When some physical links are not present or establishable they would be inferred. Consideration of physical entities as carriers or causes of physical changes enables the establishment of causal links among relevant entities and the reconstruction of the event. Because in a valid reconstruction the links should form a plausible chain, verification of the reconstruction becomes possible.

Fourth, the view of physical evidence as physical changes in entities (changed environment) provides significant insights into the procedures to be used in its retrieval. At a crime site some changes are ongoing, some fugitive, and some relatively permanent. The ongoing and the fugitive changes must be documented, collected, and preserved first and the more permanent last. The documentation process should not distort the true picture of the change, and the retrieval procedures should cause no (or as few as possible) basic categories of changes to occur in the entities being retrieved.

Conclusions

This paper has developed an integrated conceptual framework for recognizing and approaching physical evidence that would serve as a basis in training the persons responsible for the retrieval of physical evidence from the field. However, some experienced forensic scientists may feel that nothing has been suggested that was not known before. It should be noted that a workable conceptual approach to physical evidence has not previously been proposed. A scientific discipline comes into being when a body of known or discovered facts are given coherence by a concept. By virtue of the concept that physical evidence can be approached and defined as changed environment caused by energy effects, apparently isolated entities in the vast universe of physical evidence have been ordered and can be understood under a unified framework.

At a practical level it has been the experience of the authors that while teaching and elucidating the concept of physical evidence as physical change, as stated in this paper, to several classes of students over the past few years a better understanding of the subject matter was achieved. This applied not only to students who had a first exposure to this subject but also to experienced evidence technicians and law enforcement personnel. Physical evidence, presented within this framework, made much more sense to the experienced students and increased their appreciation of the link between the forensic science laboratories and the field activities, a knowledge they had not previously gained from a study of training manuals and books available on the subject of physical evidence.

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