A Proposed Interdisciplinary Curriculum in Forensic Kinesiology

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To meet the ever-increasing demand for expertise in human movement as applied to civil and criminal litigation, both private and public organizations have begun to seek the help of highly trained kinesiology specialists with advanced graduate-level university education and training. This paper will begin by identifying the key elements of the emerging specialization/subdiscipline of forensic kinesiology. Further discussion will outline the requirements for a university-based, graduate-level program designed to prepare students for specialization in forensic kinesiology. Based on this discussion, a proposed interdisciplinary curriculum will be presented.

The collection and analysis of facts surrounding most injury-related events (minor to major) have been done since ancient times. Although the most dramatic type of such events would be a suspicious or violent death, all injury-related events are unique and potentially significant. Even a short-distance fall, low-velocity sport-related collision, or work-related overuse syndrome requires a full discovery. Indeed, victims of injury-related events, law enforcement personnel, members of the legal system, and legislators have all recognized the complexities of injury-related events, and the corresponding need for a variety of specialized investigators systematically to gather, synthesize, and examine the evidence before court processes.

Since injury and death events involve complicated issues pertaining to complex phenomena, demand for competent specialists in forensic investigations has resulted in the formation of a number of university-based programs. Leading the way has been the education and training of specialists (mostly forensic laboratory scientists) involved in criminal investigations (National Institute of Justice, 2004).

Over the years criminal activity has become more complex, and so the demands for proof (evidence) of innocence or guilt generated by forensic scientists using objective and systematic methodology has increased. As such, the applied theoretical background and practices of forensic science have become more sophisticated and lead, in the case of some professions, to developing highly specific subdiscipline specializations (Kent-Wilkinson, 2008). Further, the demand for subdiscipline specialization tends to lead to the formation of graduate-level programs (Kent-Wilkinson, 2008). In an attempt to meet the needs for advanced education and skill sets, universities have begun to offer advanced graduate programs in forensic...
science. Indeed, according to the National Institute of Justice (2004), there is ever-increasing demand for graduate education and training in forensic science with expectations of good career opportunities.

Along with the advances in the forensic laboratory sciences, other disciplines have established interdisciplinary fields of forensic study and practice, such as law and order with finance (forensic audits), and law and order with medicine (forensic autopsy).

Indeed, most of the emerging forensic sciences should be considered collectively as a movement in establishing a relationship between disciplines and leading to the formation of an interdisciplinary science (Fradella et al., 2007). In some cases, university-based interdisciplinary curriculum models in forensic science have been developed (Fradella et al., 2007). However, it appears that the science programs tend to focus on the life science of biology and the basic sciences of chemistry, mathematics, and physics (Holland et al., 2006).

Fradella et al. (2007) has reviewed and summarized the various university-based programs in forensic science in the United States, most of which involve general and intermediate level courses in the life and basic sciences along with more specialized coursework in the practices and methods of forensic science and justice. Fradella et al. (2007) found degree offerings that ranged from baccalaureate to graduate degrees in most of the relevant sciences. Unfortunately, there was no mention of the human movement sciences in any of the programs mentioned in the Fradella et al. (2007) article. Further, although peer-reviewed articles suggest that the study of human movement (kinesiology) is an important discipline in some forensic investigations (Pelham et al., 2010; Pelham, et al., 2006), no reference could be found within the reviewed literature with regard to the incorporation of kinesiology in any forensic science core curriculum.

There is little information available regarding the prerequisites and requirements for a university-based program with a specialization in forensic kinesiology, particularly as it relates to the essential need for advanced knowledge and the acquisition of practices and skills. Moreover, the question of whether an interdisciplinary approach would be an appropriate one has not yet been explored. This paper will systematically highlight the interdisciplinary character of forensic kinesiology, discuss the theoretical and applied elements of forensic kinesiology, identify requirements for a university-based graduate program in forensic human movement science, and finally propose an interprofessional graduate curriculum in forensic kinesiology.

Defining a Discipline

As mentioned above, many parent disciplines (such as biology, chemistry) have developed forensic science subdisciplines. Ideally, what differentiates these emerging forensic subdisciplines lies not only in the theoretical stance peculiar to their parent disciplines (including a basic worldview of what types of properties there are and what types of laws may be discovered linking these properties) but also distinct fundamental practices and skills associated with their particular applications. In other words, ideally each would have an exclusive ownership of a body of knowledge and associated sets of fundamental practices or skills. However, in
the real world, things are not so clear-cut; many subdisciplines share knowledge (as with biology and chemistry) and skill sets (as with mathematics and physics). In some cases, it can be quite confusing to differentiate groups.

**The Science of Human Movement: A Unique Body of Knowledge and Training**

As the study of all aspects of human movement, kinesiology involves the integration and application of the concepts and practices found in the arts (e.g., film, philosophy), and the laws and principles of the basic (e.g., chemistry, mathematics, physics), life (biology), and social (e.g., psychology, sociology) sciences. From the study of human movement, various practices and skills have been developed particularly related to testing, measuring, evaluating, and describing the movements of humans under all circumstances. It could be said that kinesiology is the examination of human movement from a biopsychosocial viewpoint, and in itself is an “interdiscipline” (Pelham et al. 2010).

From another standpoint, practitioners of kinesiology view human movement through a mixture of systematically selected concepts to evince the integration of task-specific methodological skills and practices scientifically to synthesize, analyze, and describe human movement accurately. These approaches are unique to the interdiscipline of kinesiology.

The following is an attempt to illustrate the unique aspects of the proposed subdiscipline of forensic kinesiology, when compared with engineering and computer science. Contrasting forensic kinesiology as envisioned here with the exclusively computational-based approaches one might find in a consultant’s report on a forensic event will help do this.

For many years professional engineers have been consulted in accident/crime investigations. These forensic experts tend to express their findings in mathematical models. Similarly, experts in computer science can produce, through a combination of mathematical calculations and computer programming, computer animations attempting to simulate/reconstruct an accident/crime event precisely. Although professionals in the discipline of forensic engineering have used descriptive approaches in presenting their kinetic and kinematic analyses, it is the experts in forensic kinesiology with an extensive background in applied anatomy, biomechanics, and a vast array of the possibilities and limitations of human movements, who can integrate such analyses with the influences of psychomotor and environmental factors to more completely and accurately describe the events being investigated.

**Preparation of Students as Specialists in Forensic Kinesiology: Current Status in Higher Education**

At first glance, four types of university-based health professions students appear to be good candidates for our proposed program in forensic kinesiology: students who have completed courses in kinesiology, physical education, athletic training (therapy), and physical therapy.

A typical baccalaureate science program in these disciplines would require four years of full-time study (Dalhousie University, 2009a), with courses including
basic and applied human anatomy, general human physiology, exercise physiology, motor control, biomechanics, as well as introductory courses in communication, computer technology, physics, statistics, and research methods (Dalhousie University, 2009a). Additional coursework usually offered involves topics such as skill acquisition, ergonomics, sport psychology, advanced biomechanics, and fitness assessment and exercise prescription.

A Master of Science program in the aforementioned fields typically takes two to three years to complete. Required coursework usually includes graduate-level courses in statistics, research methods, measurement and evaluation, graduate seminar, and thesis (Dalhousie University, 2009c). Master of Science graduates have a good understanding of human performance in both normal and elite athletic (sport science) populations. Such graduates also have a solid background in discipline-specific qualitative and quantitative analytical techniques for studying human movement.

However, Gill (2007) has suggested that research-based graduate programs in kinesiology tend to have a narrow focus. Moreover, according to Freedson, (2009) and Spiriduso (2009) major funding agencies (e.g., National Institutes of Health) highlight the need for an interdisciplinary team approach for funding of research projects. Building bridges between disciplines allows for the development of academic teams that enhance the interdisciplinary training and strengthen opportunities for research funding (Spiriduso, 2009). At preliminary graduate levels, these interdisciplinary environments allow for cross-educational experiences. Such milieus have the potential to ensure that students have opportunities to develop an appropriately broad and flexible knowledge base.

Integration of professional programs such as athletic training with kinesiology has been identified (Freedson, 2009). Within kinesiology, at the master’s level, Freedson (2009) has identified several interdisciplinary programs, but resource allotment problems exist as they attempt to become fully integrated. Finally, according to Freedson (2009) and Spiriduso (2009), kinesiology programs have begun to recruit faculty with expertise in other disciplines. As such, along with kinesiology, physical education, athletic therapy, and physical therapy, other university-based undergraduate programs may be suitable if graduates of these programs meet the stated prerequisites.

Key Elements in Forensic Kinesiology

There are two essential elements for a successful career in any of the forensic sciences: personal character and academic background, both of which are important in the development of a successful professional in forensic kinesiology. Each of these elements will be discussed in turn.

Essential Personal Qualities of a Forensic Scientist

It should be quite clear that most accident/crime investigations are multifactorial processes. Further, it should be evident that the core competencies of critical thinking, evaluation, and decision-making based on objective data generated from clearly defined scientific methodological approaches, with effective multimodal
communication within a team of investigators, are essentials demonstrated by successful forensic scientists.

Effective management of information, including but not limited to scientifically generated data, particularly as it relates to mechanism of injury, must entail objectivity. Strict adherence to the principles of the scientific method is paramount (best practice approach). Outcomes will then be deemed evidence-based and defendable. Critical thinking should permit for the discovery of the best possible set of approaches with the goal of optimizing outcomes. Professional ethics dictate that forensic scientists must adhere to these practices.

Given the fact that many accident/crime investigations involve a multistage process where the expertise of various investigators is necessary at any given stage, the ongoing evaluation in a team environment of accident/crime scenarios is clearly required. The efficient gathering, analysis, interpretation, and transfer of information is a necessity.

The success or failure of the forensic kinesiological aspect of an accident/crime investigation will depend largely on the leadership, professional conduct, and ethics of the attending forensic kinesiologist.

**Academic Requirements for a University-based Forensic Kinesiology Program**

Although personal characteristics of the professional forensic scientist (such as leadership) can play an important role in a successful accident/crime investigation, a specific set of skills and knowledge are prerequisites for any forensic scientist, and forensic kinesiology is no exception. The authors propose that any university-based academic program in forensic kinesiology should contain, in one form or other, 5 academic requirements. Each will be discussed in turn.

*Requirement #1—Advanced Knowledge in the Disciplines of Anatomy, Physiology, and Newtonian Mechanics.* In regards to kinesiology, the esteemed scholars Rasch and Burke (1978) found that the disciplines of anatomy (structure), physiology (function), and the Newtonian Laws (mechanics) are the most relevant bodies of knowledge. A thorough understanding of each of these scientific domains is indispensable in the study of human movement (Rasch & Burke, 1978).

*Requirement #2—Advanced Knowledge in the Discipline of Pathology.* Injury and trauma are of the most interest to the professionals in the subdisciplines of forensic science. Any study of forensic kinesiology would require an in-depth examination of pathology, particularly pertinent aspects of forensic medicine/pathology.

All students of forensic movement science should be fully versed in three distinct subknowledge domains of trauma. First, the student must have advanced knowledge of tissue tolerance to trauma; second, and related, an in-depth education and applicable skills in qualitative and quantitative biomechanics and physiology with the ultimate goal of differentiating inflicted from accidental injury; finally, comprehensive understanding of the movement patterns and physical characteristics of both inflicted and accidental injuries would be of clear benefit to the forensic kinesiologist.
Requirement #3—Neuro-psychomotor and Environmental Issues Related to a Forensic Event. Sage (1971) suggested that all human movement, whether a reaction (e.g., spinal reflex) or planned, is a response to either (or both) an internal or external stimulus. To have an understanding of tissue response(s) to various modes of trauma (mechanism of injury), the student must have a clear and effective appreciation of psychological and environmental influences. Neuro-psychomotor responses to various external factors (e.g., environment, medications/illegal drugs/alcohol) can have major influences on physical performance, particularly in generating errors/mistakes, and the forensic kinesiologist must understand these factors.

Requirement #4—Research Methodology and Investigation Programming. Fact gathering, synthesis of information, the analysis of the data, and the formation of the findings must follow a clear and precise plan. Only if well-established and complete methods are used can all the relevant factors be identified and applied in developing a best-explanation (i.e., most likely) scenario.

A promising interdisciplinary, forensic kinesiology must be evidence-based in its practices; thus new knowledge generated via vigorous research is needed to justify its credibility. At the terminal specialization phase, in-depth research on topics within the scope of forensic kinesiology is required and could be conducted in laboratories extant or specifically designed for this purpose, and as with other graduate programs enhanced by highly talented and well-educated students.

Requirements #1, #2, #3, and #4 constitute the foundation of knowledge and training for the establishment of a best practice (science-based) approach in forensic kinesiology. A clear interdisciplinary feature of forensic kinesiology is the need for requirement #5.

Requirement #5—Understanding of the Procedural Facts, Concepts, and Principles of Criminal and Civil Law. Clear understanding of legal dynamics, particularly procedural aspects of criminal and civil law, is needed for forensic kinesiologists. These topics are typically offered to law students (Dalhousie University, 2009b).

A Proposed Interdisciplinary Graduate Curriculum

Kinesiology is a unique interdisciplinary, and forensic kinesiology is a unique sub-discipline within it. It involves the application of kinesiological knowledge and practices specifically to issues associated with law and court activities, chiefly those that concern accident/crime investigations and subsequent trials. Moreover, the facts, concepts, and principles that govern the practices of forensic kinesiology are dynamic and complex.

A curriculum in forensic kinesiology should employ a distinctive interdisciplinary approach. This approach would be well suited to developing the skill set and acquisition of the knowledge needed to develop effective professionals in the field of forensic human movement science. Pelham et al. (2010) clearly articulated the importance of such an interdisciplinary approach while investigating pathology/injury mechanics:
From a mechanism-of-injury point of view, since a variety of causes can contribute to such events, human movement experts must adopt an interdisciplinary perspective to analyze them, neglecting none of the relevant factors: applied anatomical, biomechanical, environmental, or psychological. The integration of scientific principles with a clear understanding of human movement at different levels of analysis enables an expert to determine whether fatal injuries may, or may not, have been produced by an accidental event, and to explain the movement sequence and patterns involved. (p. 2)

The distinctive interdisciplinary nature of forensic kinesiology allows for a more holistic approach to investigation, involving both quantitative and qualitative analyses.

To raise the profile of kinesiology training as a valid and competitive option for careers in forensics, a curriculum should be developed with an emphasis on eliminating the deficiencies found in the above-mentioned Master of Science programs. For example, in the United States, most forensic science programs have coursework on the structure and operations of the American judicial system. Generally speaking, Fradella et al. (2007) identified courses that included topics such as, the structure and functions of the court and judicial system, principles, procedures, and practices of criminal and civil law, legal evidence for a criminal trial and civil proceeding, structure and functions of a criminal and civil processing, and procedures during courtroom testimony. Criminal and civil procedures and moot court testimony are two interdisciplinary courses proposed to address these topics. These courses are essential in any forensic kinesiology program, but were not present in any of the above-mentioned Canadian graduate-level programs. Ideally, scholars from a university-based Faculty of Law could teach these courses. Along with these interdisciplinary law courses, brief descriptions of other required courses can be found online at http://tinyurl.com/4tg89jn.

Additional required interdisciplinary coursework should include the following:

1. Gross Human Anatomy—Dissection
2. Medical Physiology
3. Forensic and Medical Pathology, and the Science of Trauma
4. Advanced Statistics
5. Pharmacology and Toxicology.

Most of these interdisciplinary courses could be offered either in a university Faculty of Medicine, specifically in Departments of Anatomy (1), Physiology (2), and Pathology (3), or in a Faculty of Science, Mathematics Department (4), and a Faculty of Health Professions, School of Pharmacy (5).

The following interdisciplinary courses should be included under the umbrella of a university-based school of kinesiology:

1. Overview of the Forensic Sciences from an Interdisciplinary Perspective
2. Advanced Quantitative and Qualitative Analytical Techniques in Human Movement Science
3. Neuro-psychomotor and Environmental Factors during Intentional and Accidental Injury

4. Original research: Master of Science thesis and Doctoral (PhD) dissertation.

All programming should also place a strong emphasis on students developing effective communication skills, particularly effective transfer of information via the Internet.

Delivery of courses, particularly those that involve extensive laboratory work, should be conducted in the traditional classroom lecture/laboratory format. However, a number of theory-based courses could be offered through more convenient, off-campus, internet-based approaches. Further developments of the program could be a continuing education option, which would allow professionals to upgrade and remain current on the state of the art of forensic kinesiology.

Although a three-credit course entitled “Forensic Kinesiology” has been offered at the University of Nevada, Las Vegas (a syllabus for which was accessed online at http://faculty.unlv.edu/jdufek/kin415/kin%20415%20615%20syllabus.pdf [Dufek, n.d.]), after searching the literature, the authors were unable to find a full undergraduate or graduate degree program in forensic kinesiology. However, a number of educational programs in forensic science and its subdisciplines are currently available. One possible helpful starting point for a student interested in colleges and universities offering programs in forensic science may be the American Academy of Forensic Sciences at http://www.aafs.org/colleges-universities.

Overall, the relevance and feasibility of implementing such a program must be evaluated by determining cost of delivery with the projected generation of new revenue from prospective students who otherwise would not be interested in pursuing graduate-level education and training.

**A Hierarchical Education Model for Forensic Kinesiology**

The path of reaching a specialization in forensic kinesiology should be viewed as a succession of hierarchical educational processes. A hierarchical model with five levels, or tiers, can be viewed in Figure 1.

Each level is essential and composed of strong building blocks. For example, at the foundation level (Tier I), robust backgrounds in the basic sciences (building blocks) are indispensable. A weak building block within any of the levels will have the ultimate effect of compromising the structural integrity of the entire structure (model). As such, each level begins with stable support of the previous tier.

However, after students have strong backgrounds in the foundation sciences, the preliminary educational process within the discipline of human movement sciences can begin. With the successful completion of Tier II, the knowledge and skills have been obtained that will set the stage for advanced exploration, education, and training in the field of forensic kinesiology.

The authors propose that initial educational experiences in forensic kinesiology begin with a master’s level certificate (Tier III). The Certificate in Forensic Kinesiology (CFK) should be considered more advanced than the typical postbaccalaureate certificate program (15 credit hours), but the prerequisite of a successful completion
of a master’s degree is not a requirement as found in many Certificate of Advanced Graduate Studies programs. The authors have strategically placed the CFK program in an effort to afford maximum program flexibility by offering a broad-based program to potential candidates without major disruptions to established graduate curricula. A CFK program could be offered as one stream in association with preexisting graduate programs, particularly professional programs, such as sport medicine. However, only graduates from programs that involve coursework of the stated prerequisites should be considered.

Although more sophisticated than survey or exploratory programming found at the undergraduate level, more specialized than a postbaccalaureate certificate program, and although leading toward a doctorate, the CFK program would not be as narrowly focused as a doctorate. The CFK program would balance diversity (great breath and depth) with movement toward specialization. This feature will allow the student the opportunity to explore the program (in reasonable detail) before progressing to more advanced educational opportunities (i.e., master’s degree, doctorate). This is a conscious effort to address the desire of many kinesiology students for a full education experience. Most importantly, the graduate certificate program in forensic kinesiology would not neglect the foundation of kinesiology as the study of human movement.

A distinctive advantage of the CFK program would be the potential for cross-education experiences and training. Graduate students and established professionals

Figure 1 — A hierarchical interdisciplinary education model for forensic kinesiology.
from diverse disciplines, such as business, could combine their previous expertise with newly acquired knowledge from the CFK program leading to the development of business plans for establishing consulting firms that offer forensic kinesiological services. Another potential opportunity may exist for mature professionals in law and order (e.g., lawyers, law enforcement, military) to expand their educational experiences. These cross-training opportunities would enrich all disciplines involved.

Tiers IV and V education and training in forensic kinesiology are designed to be more specialized. At these levels of sophistication, the integration of knowledge and skills from two or more disciplines has the potential to create new knowledge or skills, leading to the integration of knowledge and skills from two or more professions that can result in the creation a new profession (i.e., forensic kinesiology).

**Forensic Kinesiology: Filling a Void**

The efficacy of forensic kinesiology in issues of criminal justice has been clearly highlighted in the above discussion. But there are also other areas of law where the subdiscipline of forensic movement science could have important roles to play.

The financial cost of injury and trauma has been estimated in the billions (Salter, 1978), and the untold personal cost of pain and suffering is immeasurable. In many of these cases, financial compensation would be justified. Specialists in forensic human movement science could thus assist in civil claims of personal loss from work-related accidents and injury. Injury and loss in domestic environments, such as slip-and-falls, motor vehicle accidents, are other instances where forensic kinesiology could aid the deliberations and decisions of the ruling justices.

At least one American kinesiology program (University of Minnesota) has promoted the notion that obtaining an advance degree in kinesiology could lead to a career in forensic medicine (College of Education & Human Development, University of Minnesota, n.d.). Support for the viability of a career in forensic kinesiology comes from the experience of the authors where consultation fees for forensic kinesiological services with public and private legal entities (civil and criminal cases) range from $50.00 per hour for an individual with a master’s degree to $100.00 to $200.00 per hour for an individual with a doctorate.

Another potential area for applying expertise of professionals with advanced education and training in forensic kinesiology is sport and law. Human movement specialists have a unique appreciation, knowledge, and the assessment skill sets to assemble and analyze the kinesiological facts surrounding sport injuries, particularly injuries resulting in disability or death, as well as injuries caused by the poor design, construction, or use of fitness and sport equipment, negligence by a coach (e.g., improper training), inappropriate behavior from a teammate (e.g., hazing) or competitor (assault), and injuries or death resulting from poor officiating. Again, human movement specialists wishing to consult in the area of sport (or physical activity) and law would require advanced interdisciplinary education and training.
Conclusions

Although for many years the mass media, including radio, television, and more recently the Internet, have sensitized many people to, not to mention popularized, the practices of the forensic sciences, scholars (Pelham et al., 2010; Pelham et al., 2006) have only recently recognized the importance to forensics of professionals who specialize in human movement. Specializing in forensic kinesiology could be a highly competitive educational springboard for career-minded students. Employment opportunities for well-paying jobs should be good. Administrators of current kinesiology program that recognize the potential to generate revenue from a graduate program in forensic kinesiology without any increased expenditures in faculty recruitment, or dedicated facility construction will increase the vitality and sustainability of their programs. Overall, successful completion of interdisciplinary education and training in kinesiology with a specialization in forensic science would appear to be a win-win-win, for the university, the student, and society at large.

References


