H21 Ur-FORDISC, or Early Statistical Methods in Forensic Anthropology

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The goal of this presentation is to review the early extension of quantitative statistical methods in forensic anthropology that provided the impetus for the development of FORDISC for use in research and casework.

This presentation will impact the forensic community and/or humanity by providing help to forensic anthropologists and other forensic scientists in understanding the origins of the multivariate statistical techniques used in their field.

A statistical approach to skeletal identification and description developed in the nineteenth century with the use of indices to quantify observational characteristics of features such as skull shape, nose shape, relative long bone lengths, and the like. An index so used had the advantage of ostensibly removing size from consideration, and allowed its adherents to claim a quantitative group characterization of shape. The French anthropologist Paul Topinard wrote in 1894 that a cephalic index (100 X head breadth - head length) of 75 and under was "universally adopted" (but there were exceptions) as defining long-headedness or dolichocephaly. Topinard also combined several sets of skeletal measurements to form a database for determining stature by average long bone/stature ratios. For example, he found stature to be seven times maximum radius length, so stature (cm) = 7(radius length [cm]) plus 3.5 cm (a constant he employed only to move from skeletal to living stature).

Topinard's ratio approach seriously misrepresented both ends of the stature range. His remedy was to divide the sample into tall, short and medium sized people. A more adequate solution, which underpins today's FORDISC*,* was first used by the British biometrician Karl Pearson at the turn of the century. Pearson applied regression, said to be the most used and least understood type of statistical methodology, in its most elementary form, linear regression, to the calculation of stature. As Pearson (1899) put it, "The theory of regression shows that the most probable value of B [for example, stature] is expressible, so long as the correlation is normal, as a linear function of A [for example, femur length]."

A step of significance in the application of statistics to forensic anthropology came in the middle 1930s. Sometimes called the Fisherian stage of discriminatory analysis after its principal originator, R.A. Fisher, the linear discriminant function was initially applied by colleagues of Fisher's to problems familiar to forensic anthropologists. E.S. Martin in 1935 used Fisher's linear discriminant function to sex a collection of Egyptian mandibles, and M.M. Barnard in 1936 used discriminant function analysis to determine the secular variation in Egyptian skulls. Barnard used seven very familiar cranial measurements: maximum breadth and length, nasal width, and height, and the bregma-nasion-basion triangle. He stressed the applicability of the technique to supplement visual sexing of crania, particularly "to investigate further the minority of cases where the sex cannot be determined, without doubt, anatomically."

The next important mileposts, theoretically at least, on the road to FORDISC appeared in the Cambridge PhD thesis of the Indian statistician C.R. Rao in 1948. Fisher's discriminant function dealt with two categories; no doubt one reason that early applications involved human crania was that sexing conveniently offers two such categories. Rao, however, provided the theoretical basis for expanding discriminant function analysis to many categories, and, if that wasn't enough for one thesis, developed a test which answered his own question on the need to establish how many characters to use, "All right, given a set of measurements, is there further information in an additional set of measurements?"

Of the two preeminent physical anthropologists of the first half of the twentieth century, one, Ales Hrdlicka, suffered, as Alice Brues put it, from "math anxiety" and detested statistics. Fortunately the other, Earnest Hooton, did not, nor did his students, many of whom, well-placed academically, contributed to modern forensic anthropology such as Harry Shapiro, Bill Howells, Fred Hulse, Charles Snow, Alice Brues, and Larry Angel. In the late 1950s to early 1960s publications utilizing discriminant functions by Fred Thieme, Kazuo Hanihara, Jose Pons, Eugene Giles and Orville Elliot, and others began to appear. Giles and Elliot's papers in particular focused on forensic applications and their work was referenced in the first forensic anthropology text, W.M. Krogman's *The Human Skeleton in Forensic Medicine* (1962). Forensic anthropology statistics, although regarded suspiciously by some and grudgingly accepted by some others in the 1960s and later, and facilitated by the replacement of calculators by computers, led by the end of the twentieth century to the spectrum of aids to forensic anthropology incorporated in such now indispensable tools as FORDISC*.*

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