5 Product optimization: approaches and applications

H.R. MOSKOWITZ

5.1 Background and applications

5.1.1 What is product optimization?

In its most general sense, the phrase ‘product optimization’ stands for the disciplined approach to product development, whereby the investigator systematically varies formula and processing conditions. In recent years product optimization has become an increasingly valuable tool for development, because it cuts time, cost and risk in the development process (Baxter, 1989; Box et al., 1978; Gordon, 1965). This paper presents a history of the approach from the viewpoint of applications, followed by an illustrative case history.

5.1.2 Historical background

Thirty years ago, in the mid 1960s, manufacturers were content to develop products by methods they considered ‘tried and true’. These methods were often ‘rifle shots’, wherein the developer submitted his or her best guess to the product evaluator. The concept of systematic product variation as an aid to development had not yet captured the attention of product developers, although from time to time one or another article on experimentally designed products would appear in the scientific literature (e.g. Gordon, 1965). Computation facilities were primitive by today’s standards, and comfort with statistical procedures was minimal. Statistics, in the 1960s, primarily involved inference to determine whether two samples came from the same sampling distribution. Modeling consumer reactions and relating these reactions to systematically varied formulations was rare, although research interest did focus on the quantitative relation between subjective reactions and physical measures of product characteristics. Psychophysicists, however, were the principal researchers who focused on the quantitative relation between magnitude of stimulus level and intensity of subjective response (Stevens, 1975).

Looking back at the scientific literature from the 1930s to the 1970s we
may well be amazed that most basic and applied researchers consistently ignored the power and benefits of systematic product design and optimization. As is often the case, however, the zeitgeist of the time did not focus on improving ways to develop products. The late 1940s and 1950s had witnessed the explosive growth of product development to feed nations starved for new products, first because of a deep economic recession, and second because of a war which had diverted material and manpower to secure military objectives. By the late 1960s, however, the era of opportunity began to wane. Fewer and fewer truly new products were being developed as a proportion of actual products introduced to the marketplace.

It was with the widespread use of computers, first as mainframes, followed by personal computers and workstations, that experimental design and optimization came into its own. The economic climate of the 1970s and 1980s appeared to promise endless growth, so researchers did not perceive the clear need to improve product development procedures. Despite the deceptive impression of status quo on all fronts, however, the availability of increasingly cheaper computing made experimental design ever more attractive. Laboratory researchers in both government and industry took tentative steps, applying experimental design to small-scale practical problems. Typically, these initial studies involved one to three physical factors, systematically varied over a modest range. Experimental design quickly proved itself valuable as a teaching aid. It showed what effects occurred by changing variables, and what interactions existed among two or three variables.

Each scientific discipline comes bedecked (and encumbered) with its own array of symbols, language, and metaphors. Scientists and statisticians involved in experimental design and modeling are no exception. The early work in experimental design pioneered by statisticians was relatively free from fixed ideas about what was 'correct' or 'incorrect' in systematically varied test designs and analysis. The primary focus was to encourage people to use a design rather than rely on unconnected 'rifle shots'. With increasing sophistication, however, focus soon shifted to the proper design and appropriate analysis. Specifically, what was the appropriate way to analyze the data? Depending upon who created the test design and developed the ensuing model and optimization, one might wind up with one of two analytic approaches: dose response functions versus iso-response contours.

5.1.2.1 'Dose-response' functions. The first approach favored by scientific researchers examined the relation between a single variable and a single response. The researcher would first develop a model relating the full set of independent variables (and their interactions) to a single dependent (e.g. overall liking). Typically, the relation took the form of an