Selling the American People

Advertising, Optimization, and the Origins of Adtech

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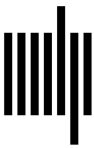

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4 OPTIMIZATION TAKES COMMAND II: THE RULE OF CALCULATION

On November 16, 1961, BBDO bought a full-page advertisement in the *New York Times* to announce a breakthrough innovation in media selection. The agency promised to find the best possible advertising placements to satisfy clients' objectives by using a method called linear programming (LP). LP is a mathematical approach for determining how to maximize or minimize the value of some criterion, such as profit or cost. BBDO was using it to create media schedules that would maximize advertising exposure among specified audience segments, given budgetary and other constraints. "This new technique, which utilizes high-speed computers," the ad explained, "amounts to giving media men a power shovel to work with instead of a spade"—a claim BBDO's president repeated later that day when the company unveiled this marvel of operations research (OR) at a meeting of the American Association of Advertising Agencies. According to BBDO, its use of LP was such a dramatic advance in industrial art that the agency had a duty to publicize the method. "We make this offer because we believe that advertising is a serious business upon which much of the strength and prosperity of the American economy depends."[1]

Charles Wilson, the director of research at BBDO, hailed this innovation as a departure from the advertising industry's "spotty history" of incorporating scientific advances into professional practice. "For every pound of real OR study that's actually been conducted," he complained, "there has been a ton of speeches and papers by people outside the advertising industry asserting that it ought to use OR more effectively." BBDO aimed to close that gap by seeing like an algorithm, "transforming the everyday operating processes

and procedures of media selection from plain language into the language of mathematics, then into equations and groups of equations." Configured this way, the realities and decision problems facing the agency's media staff could be acted on with computers at superhuman speed and scale. For all that splendor, the payoff was a straightforward appeal to efficiency: "The general purpose of this mathematical programming approach is to allocate limited resources in such a way that a business can obtain maximum profit. The media purpose is to allocate a given budget for maximum advertising. In short, the purpose is to get the most advertising for the dollar."[2]

It would be hard to overstate the fanfare surrounding BBDO's demonstration. Looking back on that day, the media director at J. Walter Thompson wrote in 1967, "The fallout from the 'nuclear' explosion that followed has affected the cellular structure of every media department in the business."[3] BBDO's ad declared the end to "a media rule of thumb," a phrase that plays on multiple meanings of "rule"—as a measure, a governing principle, and a reign of power. BBDO was promising a new regime: a rational order rooted in science, technology, and speed. The *rule of convention* would be succeeded by the *rule of calculation*.

Management science (MS), and particularly optimization techniques like mathematical programming, appeared perfectly suited to the needs of agencies' media departments. These ways of knowing and ordering the world could help media directors both with the services they were selling—systematic decisions for wringing the most value out of clients' ad budgets—and with the challenges they were facing—more media, more choices, and more demands for efficiency. The fit seemed obvious. As operations researchers at MIT put it, "The problem of preparing a media schedule is a natural one for the application of models and computers."[4] OR/MS professionals approached the media selection problem as one of optimum seeking. "Any method of media selection is concerned with deriving an optimum or near optimum schedule," explained an analyst from Arthur D. Little. That meant finding "a feasible schedule that maximizes the numerical value of some objective function."[5] Media planners had always worked intuitively to meet marketing objectives. What operations researchers did was to formalize the "objective function"—the criterion for evaluating a media schedule—as an explicit, quantitative statement. They configured media selection as an algorithmic science of decision making. When a consultant and former mathematics instructor at the US Naval Academy took stock of successful

business applications of OR in 1963, he put "selection of advertising media and expenditures" at the top of the list.[6] A decade later, business professor David Aaker described media selection models as "probably the oldest, the most developed, and most readily accepted of all the management science models."[7]

This chapter looks at how agencies used management technique to optimize media planning and buying—the operations involved in deciding how to spend advertisers' money and distribute their ads. OR/MS framed this area of the advertising business in ways that reflected corporate demands for efficiency and rationality and that favored styles of technical authority that were closely related to computerized data processing and emergent information systems. A burgeoning "mathematical elite" used optimization models to organize advertising decisions for rational discrimination, allowing managers, planners, buyers, and analysts to quickly and "objectively" discern differences in the value of audience segments and the media used to reach them. This meant that the processes for evaluating variables and alternative choices, and for reaching value-maximizing decisions, had to be expressed formally and quantitatively. It was, by design, a project of rationalization, and it implied strong pressures toward datafication of the behaviors and relationships that advertising professionals wanted to include in their models. Perhaps above all, optimization helped those professionals perform expertise. The rule of calculation gave decision makers a persuasive repertoire for justifying costly choices and taking credit when objectivity yielded new or surprising efficiencies. In both its technical and symbolic dimensions, this iteration of adtech contributed to an understanding of media buying and advertising distribution as operations that should be managed with the help of automated, data-driven decision systems.

MODEL MEDIA: WHAT OR/MS SEES WHEN IT LOOKS AT MEANS OF COMMUNICATION

As historian Ronald Kline explains, "Mathematical modeling was a hallmark of the postwar 'behavioral revolution' in the social sciences."[8] This movement is evident in advertising and marketing research. From the mid-1950s onward, journals, textbooks, and conference proceedings all teemed with mathematical models built to represent advertising decisions, marketing processes, consumer behavior, information flows, and much more. Academic

enthusiasm did not translate automatically into adoption by corporate managers, though, so industry groups took steps to evangelize OR/MS techniques. Around 1960 the Association of National Advertisers commissioned Robert S. Weinberg to prepare a report detailing the use of mathematical models for advertising planning. Weinberg was IBM's director of market research and a veteran optimum seeker. He had been an economist at the Department of Defense and a member of the US Air Force's Project SCOOP (Scientific Computation of Optimum Programs)—an initiative that applied computers to "management, budgeting and logistics problem[s]" led by George Dantzig, who famously devised the simplex algorithm for linear programming.[9] Weinberg later served as chairman of the Advertising Research Foundation's OR discussion group. After leaving IBM in 1966, he became the vice president of corporate planning at Anheuser-Busch. A 1971 profile described him as "probably the highest positioned management scientist in American industry."[10]

Weinberg's work on advertising models started from the premise that competitive pressures and the magnitude of advertising investments were pushing corporate management "to become extremely selective in choosing among various marketing alternatives."[11] Models could provide clearly structured rules and metrics for making those discriminating decisions. "Our purpose in building mathematical models," he explained, "is to describe the way in which the marketing mechanism operates. If we know the quantitative characteristics of this mechanism . . . we shall be able to project, with a specified level of probability, the inputs, in terms of dollars, physical quantities, man-hours, etc., required to maintain a stipulated level or marketing activity or to attain a given objective."[12] Weinberg was, in this instance, instructing *advertisers* how to use models to plan expenditures, rather showing *agencies* how to allocate clients' budgets, but this work indicates the appetite for rational management among large advertisers and the pressure on agencies to keep pace. A review of Weinberg's report called it "mathematical missionary work."[13] *Television* magazine stated that it "demonstrates what many experts agree might be the way of marketing and media planning in the not-so-far-off future: the use of mathematical models, or operations research techniques, as a means of relating advertising costs and market share to profits."[14]

A SIMPLE ANATOMY

Generally speaking, analysts and decision makers use mathematical models to represent the components and relationships defining any process, system, or part of reality they want to predict and manage. The elements accounted for within the models are expressed numerically, as quantities, probabilities, coefficients, and so on. Basically, these models are mathematical statements of purpose and priority—formal renderings of how (some part of) the world works, what things and relationships are considered important, what their value is to the decision maker, and what measurements are required to control the behavior of the system.

In the context of marketing, mathematical models allow managers to carefully define the decisions they or others in their organization must make and to assess the available alternatives in commensurable units of value. Having specified their understanding of the situation, the logic of how it works, and the values they want to maximize, executives can rationally, and often algorithmically, determine a course of action. The outcome of solving the equation(s) making up the model is basically a prescription for how to manipulate one or more variables under management's control so as to achieve the highest payoff (or lowest cost). These are intellectual technologies for organizing information, and the realities that information represents, in a calculable form. And they can be used to discipline knowledge work because, at least in principle, management can count on subordinates to make consistent choices when their decisions are structured by the same model.

Even in the mid-twentieth century there were many types of models. An optimization model of the sort used in advertising has some typical components. Most importantly, it has an "objective function"—a unit of value that the modeler and manager want to maximize or minimize. It is an "objective" (or "criterion") because it represents some goal or performance measure; it is a "function" because that unit of value is presumed to vary in relation to other variables in the model. To give a simplified illustration: If we assume that sales volume depends on the amount of advertising investment, then we could say that sales are a function of ad spending. And if we knew the nature of that functional relationship (i.e., how a change in spending corresponds to a change in sales), then we could determine the level of advertising investment that would maximize sales.

The media selection models examined here are generally more modest, in that the objective function represents some measure of *advertising exposure*.

This is a convenient criterion because it is presumed to correlate with the sales and profit outcomes advertisers really care about, while being easier to measure and manage. Generally, a model's decision problem is formulated as one or more differential equations, and its decision variables are the initially unknown values that are populated in solving the equation(s). In the case of media selection, decision variables are usually the quantities of advertising units purchased in each media option. The idea is to find the values for these decision variables that optimize the objective function. Solving the model shows how much should be spent on each media option to maximize exposure with a defined audience.

But decision variables are subject to limitations on their possible values. Constraints include the advertiser's budget, the supply of advertising inventory, contractual obligations, subjective preferences (e.g., a client's desire to advertise, or not, in a particular medium), and logical guardrails that prevent a model from making absurd recommendations, such as telling a media buyer to purchase a *negative* quantity of inefficient ad placements. The input data for the models include ostensibly empirical measures, including the size and composition of the audience for a given media unit and its price, and estimates and parameters derived from professional judgments about how effectively each medium will carry an advertiser's message and influence consumers.

PURPOSE AND PRIORITY

An interesting implication of these designs is that they forced model builders to explicate their values and objectives. We therefore get a glimpse at what marketers and OR/MS experts saw when they looked at advertising and media. In a 1958 paper about predicting advertising results, an operations researcher explains the point of the whole enterprise: "The results that businessmen are interested in are profits. I know there are many legitimate reasons why business supports advertising programs, but in most cases the result that is looked for is improved profit through an improved sales position."[15] This view was not universal in OR/MS, but it was undeniably predominant. As two MIT researchers explain in their textbook *Management Science in Marketing*, "advertising should be viewed as an investment, and the goal of advertising should be to maximize the returns on investment."[16]

This disposition leads to an understanding of media as extensions of the marketing system and as means for the efficient organization of consumer

populations as investment opportunities. OR professors and ad agency consultants David Miller and Martin Starr define media in their 1960 book as "the instruments by means of which communication or advertising strategies can be fulfilled."[17] They go on to elaborate that the *audience* is the key element: "a medium is nothing more than a communication channel that can be observed. One of the main distinguishing features, therefore, is the audience with which each channel communicates." Miller and Starr also identify a "great variety of demographic and psychological factors," such as income and intelligence, that can be used to classify audiences: "Occupation, years of schooling, number of children, social poise, degree of tension, credit standing, and frugality are just a few examples of other possibilities."[18] And they urge specificity in defining which audience to target:

> The decision-maker selects certain characteristics which he believes are important attributes of potential customers. He must also be prepared to specify how much of each characteristic is desirable. It is not enough for him to state that intelligence is a significant variable with respect to the sales potential of the consumer; he must also specify that some intelligence level—say four, rated on a scale from one to ten—characterizes the best level of consumer intelligence for his purposes. In doing this, the decision-maker is choosing what he believes to be the most favorable state of nature.[19]

A British operational researcher who worked for several large advertisers proceeded from a similar orientation. Advertising campaigns, he explained in 1962, typically aim to either "persuade some portion of the population to take some definite course of action, or to create and maintain an idea or an attitude in their minds." This is obvious enough, but then he stresses the importance of media distribution: "Whatever the objective may be, the essence of advertising is that a message must be conveyed from the advertiser to some class of people whom we call the target population."[20] Another operational researcher noted that computing machines process the world through a similar optic. Describing the potential for media planners to combine data from different media and devise all-inclusive media plans, he explained that the computer "regards a media vehicle as simply a probability of delivering a certain weighted impression to an individual, and . . . indifferently weights individuals by demographic or purchasing or attitude characteristics."[21] As the director of print media at Young & Rubicam put it, computerization enabled commensurable measures of "apples and oranges," as even different media could be "compared in terms of their vitamin content."[22]

In a classic critique of audience measurement, Ien Ang shows how audience ratings produced "a discursive framework" that enabled the television industry to "know its relationship to the audience" in a statistical idiom.[23] Optimization also produced a discursive framework. Experts classified and materialized audience segments and the media inventory representing units of their attention as quantitative values and probabilities—as information that could be handled with computers and mathematical formalisms. Optimization models forced analysts or managers to explicate their objectives, strategies, and values and to clearly identify the data needed to calculate rational choices. A close look at OR/MS in advertising shows that this technical community regarded media as useful mechanisms of social sorting, enabling the efficient distribution of ads to apparently profitable populations.

OR/MS thus brought particular ways of seeing and counting to the processes of evaluating consumers and circulating advertising money throughout media systems. Mathematical modeling formalized rational, algorithmic procedures for ranking and discriminating among a sometimes staggering number of alternatives. Working through all the possible investment choices available to advertisers within a limited time required "a systematic technique for calculation."[24] This was exactly what agencies promised to provide with their media services. They defined media planning and selection as an applied science of decision making.

DECISION MAKING AND DECISION MAKERS

Commercial applications of OR/MS were intended to improve executive decisions. As marketing theorist Wroe Alderson put it, "an executive with a problem is an individual responsible for decision and beset with uncertainty as to the course of action to follow. To solve a problem is to reduce uncertainty to a point that will permit a choice to be made."[25] Marion Harper Jr., president of the McCann-Erickson agency, considered the "virtual explosion of research . . . in technology, operations, and marketing" around the start of the 1960s as an "investment in management decision-making—to help determine the future environment for a particular course of action, or to indicate the superiority of one course of action over another."[26] By 1965, the research director at Young & Rubicam noticed "an increasing demand from top management, particularly during the past decade, for more rational decisions in the marketing area. . . . The tolerable range for error has shrunk

to disconcertingly narrow limits. Consequently, means of reducing uncertainty are urgently sought."[27]

Management technique promised a salve for this anxiety. OR/MS imported into advertising a particular repertoire for defining problems and their solutions—what sociologists might call a "technological frame."[28] In particular, operations researchers positioned media selection as terrain for decision theory, which Kenneth Arrow defined as "a formalization of the problems involved in making optimal choices."[29] OR/MS framed agencies' media planning and buying activities as mathematical and engineering problems that lent themselves to modeling and optimum seeking, an ostensibly progressive contrast to traditional styles of intuition and negotiation, such as the fabled three-martini lunch. The rationalization of media selection—as procedures to optimize a formally defined objective function—made new demands on the organizational and calculative environment. It called for (and reacted to) technoscientific expertise, more abundant and detailed behavioral data, and expanding facilities for rapid computation and communication. Managers were trying to make this kind of advertising work legible for algorithmic, machine-supported decision making. Under the rule of calculation, media selection was configured as processes that could be expressed mathematically and executed programmatically.

Compared to other advertising operations, the allocation of budgets seemed like a great candidate for formal treatment. Media selection was information intensive and punctuated by frequent decision-making events. Those decisions involved high levels of choice and uncertainty, yet they had to be handled as routine matters. In a 1955 textbook, a lecturer at Columbia University writes, "One of the most important services the agency offers its clients is the selection of media best calculated to carry the advertiser's message. This service entails considerable knowledge of individual media and the markets they represent."[30] Calling the media buyer, or time buyer, "a key controller of advertising dollars," the vice president in charge of media at Leo Burnett said, "Ever since broadcasting came into prominence as an advertising medium . . . the principal job of the timebuyer has been decision making."[31] BBDO's vice president of research agreed: "Buying time or space is a decision making process."[32]

The media function evolved in tandem with data processing and analysis. Agency media departments were already calculative spaces, buzzing with information and the industrial media for managing it. Describing the

experience of navigating BBDO's media department, the director of advertising at Pepsi said, "I'm quickly lost among the calculators, ARB's, Nielsen's, SRDS's, salesmen, availabilities, worksheets, overtime slips and all the other elements that go into one of the busiest departments in the agency."[33] The industry registered "major tremors" in the early 1960s, as media departments appeared to be "entering the space age."[34] Much of the excitement centered around computerization and OR/MS techniques, which had been "developed at a cost of hundreds of millions of dollars in the weapons and space race," as a systems scientist who had worked at MIT's Radiation Laboratory noted in *Television* magazine.[35] Enthusiasts welcomed "a new age of scientific and efficient media planning," while skeptics "dismissed the computers as a publicity gimmick." In any case, "the dialogue on computers" led to contests over the status of information and technical expertise.[36]

The potential ascribed to computers and scientific innovations elevated the professionals associated with them. The media managers and research directors who worked on OR projects were cast as apostles of a progressive, rational future and paraded through the spaces and publications where the industry assembled to talk about itself. As one journalist put it in 1963, "The media man with a computer is taking on new stature in the agency field as his calendar fills out with speaking engagements to address his fellows and the media multitudes on the wonders of a new age."[37] Media specialists staked claims to new prestige, expertise, and responsibilities, or in some cases, they had those thrust on them by other executives who were eager to capitalize on the cultural hype around futuristic technoscience. "It's generally agreed," *Sponsor* reported, "that with an ever increasing volume of progressively more sophisticated data on its way to aid media departments in performing their functions more effectively, more sophisticated analysts and researchers will be needed, and that segment of the department will take on greater stature."[38] As one executive forecast in 1964, "Tomorrow's media buyer will operate . . . as strategist and tactician. His new importance will result from improved and expanded media forms and the accumulation of instantaneous automated data on media and markets."[39] Computer systems programmed to execute mathematical analyses would rapidly convert data into recommendations about how to adjust advertising strategies and optimize media plans. "In that highly automated era the logical candidate to assume authority for use and control of this complex is today's marketing oriented timebuyer—the media specifier with his unique insight into the almighty power of the ad dollar."[40]

Using management technique to climb the status hierarchy required some finesse. Not everyone agreed that media selection could be as formal and precise as a computerized science of optimization seemed to imply. Some media personnel were actually empowered by treating it as an art. This preserved the intangible value of their unique experience and judgment, protecting them from automation or the encroachment of efficiency experts. They could deflect accusations of irrationality by insisting that their work defied any strict scientific accounting. The media director at Grey Advertising wrote in 1960, "as yet, we simply do not have a scientific body of knowledge about media selection." Importantly, though, he stopped short of denouncing scientific aspirations. "All business is an art. Media selection, in fact, with the data now at its disposal, probably comes closer to being a science than any other brand of the advertising arts."[41]

Despite these tensions, industry discourses were clearly normalizing the perceptions that decision making in advertising required a scientific disposition and that media departments were poised to take advantage of powerful new means of obtaining and using information. Media selection was becoming increasingly complex. Planners and buyers had to choose from more and more publications, broadcast stations, and combinations of advertising opportunities. Experts liked to illustrate the computational burden with colorful vignettes. As the manager of Y&R's media department put it, "a media buyer selecting 10 media from a group of 100, has 17,310,000,000,000 different alternatives available to him." Analyzing one alternative per second around the clock, it would take half a million years to evaluate all the choices.[42] IBM's Weinberg gave an even more dramatic demonstration. By permitting additional decision factors, such as discretion in the magnitude of spending (rather than just choosing whether to use a certain medium), he portrayed the analytical challenge as truly astronomical. "If we had 10 different media alternatives, and we wanted to decide how much to spend on each, and we were willing to allow one of a hundred possible expenditure levels, and wanted to literally search each combination, we would have to look at a hundred quintillion possibilities." If each possibility were encoded on an IBM punch card, he said, "we could construct 113,140 piles from the earth to the sun."[43] Commonsense constraints would rule out the vast majority of these options, but the universe of plausible choices could still number well into the millions.[44]

Helping decision makers cope with these complexities was part of the pitch that operations researchers peddled on Madison Avenue and that

agencies repeated to their clients. They also promised to unlock hidden value through more massive and rational data analysis. Proponents claimed that these models and computer methods could produce media plans that defied traditional norms and intuitions but were quantifiably more efficient at satisfying marketing objectives. The following sections examine some specific designs.

MEDIA OPTIMIZATION MODELS

LINEAR PROGRAMMING AT BBDO

BBDO worked with prominent operations researchers and the data processing firm CEIR to develop a computerized media optimization model. It was based on the "Dantzig simplex" algorithm for solving a linear program.[45] The basic idea behind staging media selection as an LP problem, explained consultants Abraham Charnes and William W. Cooper, was to spend the advertiser's money on a schedule of media placements that would "achieve the maximum total impact on a target audience."[46] More formally, the objective function in BBDO's optimization model—the criterion it was designed to maximize—was called "rated exposure value."

"Exposure" meant that potential consumers saw or heard an advertisement. What made those exposures "rated" was that the media planner (1) assigned a weight or score to each audience segment, representing its sales potential and its relevance to the advertiser's marketing plan; and (2) assigned "impact values" to the available media options, based on qualities that could affect consumers' responses to advertising (e.g., strength of a broadcast signal, editorial tone of a magazine, need to demonstrate a product in color or with moving images). Based on the worth of audience segments and the expected effectiveness of media vehicles, as well as audience ratings indicating the distribution of those segments across those media, each advertising option could be scored in terms of rated exposure value. Assembling a schedule that maximized rated exposure value within the allotted budget then became a straightforward optimization problem, and "the simplex algorithm provides an exact and unique solution."[47] The algorithm quickly searched the available alternatives to find *one best schedule* that satisfied whatever constraints were specified (e.g., spending a certain part of the budget on television or reaching a certain percentage of people in a specified income class).

BBDO's David Learner claimed the computerized LP model generated schedules that delivered 30 percent more rated exposure value than media planners were able to achieve manually.[48] The calculations themselves were not intractable to manual computation, but electronic data processing dramatically accelerated their pace and, together with the LP technique, increased by orders of magnitude the permutations of media placements that could be evaluated within the time available for planning and buying. *Business Week* reported that this system let BBDO "quickly solve problems of advertising media selection that formerly took weeks or even years."[49]

In addition to recommending the optimal schedule, the LP output included a "sensitivity analysis" that indicated to what extent the result was influenced by the constraints, parameters, and estimates entered into the model. With sensitivity analysis, the LP system not only told media personnel how to optimize a schedule within predefined constraints but also indicated how changes in those constraints, as well as other variables, could affect the objective function. These calculations quantified the extent to which corporate advertising policies, which might be motivated by tradition or instinct, were inefficient when measured against the stated objective. Sensitivity analysis also revealed how precisely certain values needed to be specified, and thus whether it was necessary and economical to collect more data.

In a sense, LP provided an accounting of a decision, testifying to its rationality or documenting where it deviated into irrationality. If an advertiser insisted on placing ads in a prestigious publication because it flattered top executives, or if a company followed the more mundane but still arbitrary policy of investing a certain percentage of its budget in magazines, the LP's sensitivity analysis could specify the cost of those choices. Learner observed that this information "is really at the heart of the management decision-making value of the model."[50]

Although LP sounded impressive, it was no magic formula. "Because the problem of media allocation can be so readily formulated to conform to the problem structure required by the linear programming algorithm," wrote one researcher, "this approach was among the first tried by advertising agencies."[51] Its application in advertising was later described as "a classic case of a technique . . . looking for a problem."[52] A business professor at Columbia University complained that LP was "often misused as a publicity vehicle for ad agencies."[53] Another observer worried that both advertising and OR would

suffer "if [LP] models are used so that an agency can say, 'look how scientific we are.'"[54] Even admiring analysts acknowledged that because BBDO so "aggressively publicized" its model, rivals and skeptics were inclined to decry the entire effort.[55]

Despite LP's provenance and BBDO's claims about its performance, there were many doubts about how well it worked. Critics pointed out that media selections guided by LP often differed little from intuitive judgment, and its output depended on assumptions and estimates made by the advertising professionals who evaluated audience segments and media vehicles.[56] Indeed, it was possible for media planners to set the parameters such that the model's output would justify whatever they wanted to do. The head of research at Ogilvy, Mather & Benson said, "We tend to think that when we punch data into a machine, it becomes fact. Actually a lot of the information put in here is purely subjective."[57] According to a systems analyst from IBM, "Analytical optimization techniques, such as linear programing, frequently employ unrealistic simplifications as with a linear objective function (which is often not linear) that maximizes media exposure (which often is not the central problem)."[58] As he and many others noted, it seemed implausible that there was a linear relationship between the volume of advertising exposure and the value or effectiveness of advertising (i.e., that each exposure was equal to the ones before and after it). This assumption, one researcher remarked, "is like saying that three girls aged 20 are equivalent to a woman of 60."[59] BBDO denied that its use of the method assumed strict linearity, but the perception of this deficiency stuck. Operations researchers tried using nonlinear and dynamic programming to better account for the realities of media selection, but even large computers were still overwhelmed by the requirements for solving these problems by the end of the 1960s.[60]

Despite these controversies, technical experts portrayed mathematical optimization as an important *cultural* advance. Herbert Maneloveg, BBDO's media director, explained that the purpose of using LP was not just to calculate but also to achieve a more calculative disposition. The aim, he said, "is to reorganize and discipline our thinking, to make sure our precious few advertising dollars go where they can do the most good and show our clients exactly where it goes."[61] Mathematical modeling and optimization were part of a rationalizing and quantifying project. According to an internal BBDO memorandum, LP "helps (the media planner) by making him get a clear

picture of his objectives and his own judgmental evaluations."[62] "Because we are dealing with mathematics," Learner explained, "everything that we can or cannot do, each kind of data, each management decision must be precisely stated."[63] BBDO was codifying media decisions, a crucial precursor to automating those decisions.

New York University professor Darrell B. Lucas also highlighted the broad significance of mathematical modeling, despite its limitations. Lucas helped BBDO develop the LP system, and he defended its method of accounting numerically for estimates, unknowns, and *qualitative* factors: "What is the value of so magnificent a mathematical formulation if it still has so much in it that is subjective? . . . In the first place, it forces us to systematize our thinking, and to quantify those vague values which have been both our weakness and our protection in the past. Secondly, the use of this procedure enables us to make the utmost gain from such facts as we already have; and we do have some substantial facts."[64] The state of the art would progress, Lucas argued, as researchers marshaled these facts and methods "in a continuous attack on areas where once we had only subjective judgements as guides to values."[65] DuPont's OR specialist, Michael Halbert, likewise praised the effort, noting that "the explication of subjective techniques" was itself "a significant breakthrough."[66]

BBDO's use of mathematical programming helped make media selection legible and executable by computing machines. It also revealed limitations in the way media planning problems had been defined, and it exposed the inadequacy of available data for populating these equations. It made particular demands of knowledge and analysis that fit with the mathematical thrust of management technique. Professionals at other agencies shared these perceptions about the reformatting of their decision space. "Because the computer is a logic machine," JWT's media director explained, "it has forced us to define our audience objectives more carefully, to proceed in a rational step-by-step fashion throughout the analytical process, and in the end has made us face up to some hard decisions in evaluating media which we used sometimes to evade."[67] The director of information systems at Benton & Bowles also observed that even imperfect applications of optimization methods like LP catalyzed shifts in data creation: "Advertising and Marketing Research directors began to call the Management Scientist in at the early stages of the design of their experiments. . . . As a result, *some* data collected

began to take on the right form for the model; and *some* models began to predict with *some* measure of reliability. This in turn encouraged *some* more attempts at model building—so a cyclical evolution had begun."[68]

YOUNG & RUBICAM'S HIGH-ASSAY MODEL

Researchers at Young & Rubicam experimented with linear programming in the late 1950s, but they were unwilling to tolerate the simplifying assumptions needed to compute a mathematically "best" schedule. In consultation with Martin Starr of Columbia University, Y&R developed what it called the high-assay media model. It was an algorithm—a set of sequential instructions—that told planners how to spend an advertising budget. The firm likened it to gold mining: "Think of the mines as being different media, and the gold as sales prospects."[69] The model was designed to mine all the available gold from the medium that best met the advertiser's goal and then move on to the next best choice.

High assay belonged to a class of "iteration models." It assembled a schedule in a sequence of steps, each time selecting the media option that returned the most value per dollar—or "the lowest cost per prospect obtained," as Kenneth Longman put it.[70] Making the optimal choice at each discrete decision, high assay was an example of a "greedy algorithm."[71] This was technically a nonoptimizing, heuristic approach, since it did not necessarily arrive at the best choice for the entire decision set. Rather, it aggregated a bunch of locally optimal choices, achieving *near* optimization with much lower computational demands than LP. But Y&R did not always bother to make this distinction. It told *Advertising Age* that the computer would analyze data with a programmed "decision system" and then produce a media schedule with "optimum reach, frequency, and periodicity."[72] Joseph St. George, a manager of media and computer systems at Y&R, said, "If our decision system is correct, if we have completely accurate media data and ad impact data, and if we have made an exact appraisal of our prospect and market situation, then we should have confidence that our computer will produce the perfect recommendation."[73]

The system's objective was "minimizing the average cost per customer obtained."[74] To do this, media planners input three types of data into the agency's computer: (1) consumer-product behavior (e.g., brand share, prospects' demographics, probability of switching brands, customers' purchase rates); (2) consumer-media behavior (e.g., audience size and composition,

rate structure for each medium, duplication of audience members across media options); and (3) consumer-advertising behavior (e.g., effect of ads on brand switching or loyalty, effect of added exposure over time). The name "high assay," as one observer later reflected, conveyed the notion that some audiences are worth more than others, "that a marketer's top priority is to find ways to identify and discriminatingly reach these high value target customers."[75] According to St. George, this was accounted for by relating data about media audiences to "market-prospect data which contains information about who we wish to sell, where they live, how easily they are persuaded, etc." Like BBDO, Y&R recognized that the state of the art left much room for improvement, but the agency saw this approach as putting its media department on a more rigorous footing. "Realistic appraisal tells us that at this stage we do not have all the information and data we need," St. George admitted. "But, used judiciously, these models can help us pinpoint areas in which we must make subjective judgments, and can force us to be much more scientific about ways in which we invest our clients' ad dollars." He concluded that "decision models are going to be a fact in all our lives in the years to come."[76]

J. WALTER THOMPSON FOLLOWS SUIT

J. Walter Thompson entered the OR field with less publicity than its rivals, but it quietly kept pace. When JWT acquired its RCA computer in 1963, the agency also acquired Norman E. Sondak, a data processing manager from RCA, to oversee the installation, and he stayed on to manage JWT's computer operations. Like the other experts discussed earlier, Sondak believed computer usage demanded exacting, quantitative thinking. "If one can't express a problem in numbers, one really knows very little about it," he said in the company newsletter.[77] Sondak and the computer arrived not long after JWT hired an OR consultant to optimize media selection.

By the late 1960s, JWT had organized an "integrated system for media planning."[78] According to a written summary of the system, the first step in the agency's planning process involved using multivariate analysis to divide the consumer population into market segments, "each with a specific purchase probability."[79] Identifying the inter-correlations of variables that most powerfully predicted certain buying behaviors (e.g., age, gender, income, education), this "automatic interaction detector" method produced a tree-branch arrangement of increasingly narrow subgroups, many of which had to be reaggregated to be practical targets for media buyers. "With this

information," the document explains, "we can get a very accurate picture of the relative value of various kinds of people."[80] Staff then used one or both of JWT's computerized selection models to pick a media plan that would efficiently satisfy some specified objective. One model evaluated alternative schedules that were already assembled; the other automatically chose the optimal combination of media options.[81]

The agency continued to build computer-based optimizing tools in subsequent years.[82] According to a bibliography circulated to media personnel at JWT's New York office, from 1970 to the end of 1973, the agency's Media Analysis Department produced eleven reports or manuals pertaining to the computer resources used for media functions. These covered online computer systems, data processing procedures and services, and various media-specific programs.[83] The department boasted in a 1970 memo that "the informational and technical resources available to our media people are unmatched in the advertising business."[84]

SIMULMATICS' SIMULATION

As full-service agencies sharpened their calculative tools, specialized vendors marketed rival products and services. Perhaps none piqued more interest than the Simulmatics Corporation. In the early 1960s Simulmatics used a computer simulation method to evaluate media plans for large marketers such as Colgate-Purina, General Foods, and DuPont.[85] The company fabricated a hypothetical sample in the form of a database representing the US population and its media habits. The sample included 2,944 synthetic individuals whose probability of being exposed to an advertisement in a given media vehicle was defined as a function of their socioeconomic and demographic features. Using "an electronic brain that performs 250,000 separate calculations per second," Simulmatics' "media-mix" model simulated those individuals' media behaviors to forecast the audience exposure of a given media plan.[86] The company claimed this enabled advertisers to realize media spending efficiencies of up to 30 percent.[87]

Computer simulation did not optimize media selection. It was a tool for evaluating schedules that media planners had already assembled. An operations researcher from RCA contrasted it to LP by describing simulation as a technique for finding a solution when "the algorithm for improving the system is missing."[88] Instead, the media-mix program predicted the likelihood of reaching desired consumer targets with alternative plans. The computer

reportedly output as many as four thousand tables of information detailing the media consumption of Simulmatics' data-based population.[89] The media-mix model also classified consumers in ways that went beyond basic demographics. "For example," Simulmatics' Alex Bernstein explained, "for each individual, what kind of car does he own and how old is it? How does he or she distribute purchases between supermarkets and drug stores? Between grocery and drug stores? Does he live in a hard or a soft water area?"[90]

James S. Coleman, a professor at Johns Hopkins University and a member of Simulmatics' research board, expected computer simulation to precipitate a "revolution in the development of advertising and marketing techniques."[91] The company even planned to "shoot for the ultimate goal in advertising prediction: forecasting a campaign's sales effectiveness."[92] This chutzpah was characteristic. Chairman Ithiel de Sola Pool boasted that Simulmatics "pioneered in the application of computer techniques to the market place. After a great deal of intricate research and the accumulation of tremendous amounts of data, we devised a mathematical method to evaluate the probable reactions of consumers to the introduction of a new product or advertising campaign."[93]

Simulmatics made a big splash. But Pool's pioneering claim was a bit flattering. The company was not alone in recognizing the potential of computer simulation. To give one colorful example, William Fair, cofounder of the Fair Isaac credit scoring company, described an elaborate plan for programming a computer to run simulations of business decisions to identify the most profitable courses of action. "Essentially," he explained in 1953, "the proposed computer is an apparatus for making an analogue model of the economic world centered on the business in question. The entrepreneur describes his world (quantitatively), chooses his policies, and turns on the machine. The machine then runs 'into the future' at the high speed permitted by modern design, and delivers the answer on what will happen if the model fits reality."[94] Consultants at Arthur D. Little reported using computer simulation as early as 1958 to test "alternative advertising campaigns on a hypothetical customer group."[95] Around the same time, Richard Maffei at MIT used simulation to help Heinz with distribution logistics, and he claimed to be working on similar methods to study the relationship between the company's advertising and its profits.[96]

Advertising agencies—together with computer service vendors like CEIR—were also entering this field, albeit after Simulmatics. As Jill Lepore

points out, "these agencies had better data than Simulmatics" from their own market research units, some of which had been established decades earlier.[97] A few agencies even used simulation methods to fill gaps in their databases. Y&R trademarked something called the Data Breeder Model, which was used to make estimates "where existing data are inadequate." Starting with known information about consumer behavior, the computer "produce[d] the best estimates of missing information."[98] Just like Simulmatics, Y&R used this system to predict how a media plan would reach specified populations.[99]

Clearly, the advertising industry saw promise in what Simulmatics was doing. To some observers, simulation represented a productive integration of behavioral and management sciences. Weinberg gave Simulmatics some wry (and prescient) praise: "One of the things wrong with advertising research is that the psychologists got hold of it. This may be dwarfed by the damage the mathematicians are going to do—I am not sure—but it seems to me that somewhere along the line, someone has to marry the mathematicians to the psychologists." Simulmatics' media-mix model, he said, "provide[s] a very interesting device for doing this."[100] Others saw simulation as valuable for understanding consumers and audiences. We tend to think of media in this period as exclusively organizing people into undifferentiated "masses," but media managers appreciated that computers and new methods of analysis could help them operationalize finer and more flexible consumer targets. As a vice president of media at Benton & Bowles explained in 1962, "Simulation opens a new horizon and places emphasis upon individuals rather than households."[101] That same year, the president of CEIR claimed that analyzing a "statistical equivalent of the entire consuming public" would allow advertisers to move closer to their true objective of maximizing profits: "with the introduction of new analytical techniques and the new computer machinery, achievement of the delicate balance necessary to optimize profits may become a reality."[102] Computer simulation was a charismatic medium onto which the advertising business could project its dreams for the future.

MEDIAC: A MODEL UTILITY

The final media decision system examined here was born on the same campus as Simulmatics. At MIT in the 1960s, John D. C. Little and Leonard Lodish developed a number of marketing and media selection models. Little joined the School of Industrial Management in 1962, and he is thought to be the first student to earn a PhD in operations research.[103] Funded by the US military

and large corporations such as Mobil Oil, Little's research helped extend OR/MS into a subfield called marketing science. Much of his work focused on computer-based adaptive control systems, "real black boxes for a technical management of markets," as Franck Cochoy puts it.[104] Essentially, these systems assembled and analyzed information about marketing environments, organizing the basis of managerial decisions. Lodish was Little's student and had previously been an OR analyst for the Mead Corporation. He joined the Wharton School at the University of Pennsylvania in the late 1960s.

Little and Lodish designed models for optimizing (or nearly optimizing) media selection via dynamic and heuristic programming. They worked under the auspices of Project MAC, a large research and development initiative, well known for its contributions to computer time-sharing, sponsored by the Department of Defense's Advanced Research Projects Agency. Little and Lodish characterized their main innovation as "a media planning calculus," which was embodied in a program called MEDIAC (Media Evaluation Using Dynamic and Interactive Applications of Computers) and accessed using a terminal connected to a time-shared mainframe. "By a 'calculus,'" they explained, "we mean a system of numerical procedures for transforming data and judgments into a schedule. The model supplies the structure, the user supplies the data and judgments, and the computer supplies the muscle."[105] Perhaps because of their affiliation with Project MAC, Little and Lodish hailed MEDIAC as a testament to the power of computers, which they called "enthusiastic clerks," capable of examining many more advertising alternatives than was possible with manual calculations.[106] They compared MEDIAC favorably to existing media selection models by noting several unique features: it accounted for advertising effectiveness "in greater detail"; its "on-line" computer system afforded continuous querying of a database via the remote console's user-friendly interface (which meant not only more timely information but also the possibility that media personnel could learn to understand the model through frequent human-machine interactions); and it was computationally efficient and thus economical in terms of the cost of computer time.[107]

The model's objective was to maximize total market response to advertising—a criterion representing the sales expected to result from the level of advertising exposure achieved by a certain media schedule. To start, the population was divided into customer segments and characterized according to the "sales potential" of the people in each group. Each segment was also

defined by its media habits, allowing planners to estimate the distribution of market segments across media options. Like other operations researchers, Little and Lodish held that "the main purpose of media is to deliver messages to potential customers efficiently."[108] Therefore, they evaluated media based on their "exposure probabilities" among the people in various segments and their "exposure value." Exposure value was a subjective quantification; it represented the presumed power of an ad placed in a given medium to increase the disposition of someone in a given market segment to buy the product.[109] And, unlike some other models, MEDIAC accounted for the diminishing impact of ad exposures over time and at high frequencies.

Calculating each media unit's "increment of response per dollar," MEDIAC helped media planners assemble a schedule that maximized sales potential across market segments. Selection could be optimized with dynamic programming if planners were considering just one or two market segments; beyond that, computation time became prohibitive, so a heuristic search was used to find a near-optimum solution.[110]

Little and Lodish described their goal as increasing advertising "productivity." They claimed to improve media planning by 5 to 25 percent, as measured by the model's definition of market response.[111] "Most media planning is rather macroscopic," they said, and focused mainly on "simple efficiency measures" such as cost per thousand exposures. "We want to show how more phenomena can be handled with greater ease than these usually are today."[112] Computer time-sharing provided the capacity to account for more "facts and phenomena" within the media calculus. In its first few months of operation, MEDIAC was used to allocate "several million dollars of advertising."[113]

In addition to their research, Little and Lodish are notable for their entrepreneurialism. They founded a company, Management Decision Systems, and Little claims that he recruited clients for their consulting work from the summer seminars MIT hosted to teach executives about OR/MS.[114] They sold the MEDIAC model to a firm called Telmar, a leading vendor of computerized media planning and analysis tools—what might be considered an early adtech company. Founded in 1968 by a media supervisor and director of data systems at Y&R, Telmar was "staffed by a group of bright young computer wizards," according to the *New York Times*.[115]

Observers saw the commercialization of MEDIAC as a catalyst for the wider adoption of OR/MS techniques. Two other management scientists at MIT described MEDIAC as a type of "model utility," an already assembled

program or algorithm that customers accessed through a data communications network, or "computer utility." They expected these complementary utilities to enable many more firms to "usefully and economically take advantage of the computer and marketing models."[116] At least some working managers agreed. By 1970, marketing research and information system specialists at Coca-Cola reported that "the capabilities of the computer now allow us to use many statistical techniques which have been around for some time but which have not really been feasible due to the large amount of computation required." Explaining that "statistical and operations research analysis methods are available in the form of several software packages," they specifically praised Little and Lodish's company and its products.[117] At least thirteen agencies reported using MEDIAC for media planning in 1982, although only a couple were still using it in 1994.[118]

A textbook from the early 1980s described MEDIAC as an important advancement in media planning models, both because it accommodated more intricate details and because it was packaged as a complete decision model available for "on-line access via a remote terminal." Unfortunately, its sophistication probably limited its adoption: "it may be too complex for most media planners."[119]

TOWARD A RULE OF CALCULATION

These models were ahead of their time. It would take a broader set of enabling conditions to furnish the data and commercial relations necessary to really exploit these techniques. But early experiments with OR/MS were agents of that change. They represent a loosely organized attempt to reformat the infrastructures and political economy of knowledge in advertising and to link corporate aspirations to dreams of mathematical optimization. They prefigure the culture of data-driven advertising and its orientation toward surveillance, profiling, and discrimination. Essentially, optimum-seeking approaches to media selection tried to identify value more precisely; express that value more formally and in commensurable, quantitative units; and thereby facilitate rational, algorithmic choices. Management technique looked at audiences and advertising opportunities in ways designed to help planners discern new actionable efficiencies. Practically, this was still a long way from today's automated auctions, and early optimization models did not swiftly brush aside entrenched organizational routines and power relations by their sheer

force and elegance. But the auctions and platforms that circulate advertising money and consumer data today would be impossible without the recurring efforts, started here, to configure media decisions such that the potential value of different advertising investments could be rapidly computed, compared, and discriminated using models and machines.

A critical implication of all this is that the OR/MS paradigm defined media as means for achieving advertising objectives and scored them with respect to their efficiency in organizing the attention of specific consumers. BBDO's LP model, for example, was not designed to cultivate an informed and compassionate citizenry or to help diverse and resilient communities govern themselves. Its explicit and only goal was to maximize rated exposure value. Many people consider it self-evident that advertising is necessary for democracy because it pays for journalism; yet these media selection techniques materialized the business's deeper commitments to treating media as differentiated investment opportunities and to optimizing those investments. BBDO's approach even implied that basing investment decisions on subjective perceptions about the qualities of a media outlet was irrational, and quantifiably so. As BBDO's media director explained in 1962, the LP method enabled the agency's planners "to arrive at a final media recommendation that concentrates on a marketing problem and not on the media themselves."[120]

There is irony and contradiction here. BBDO and clients like DuPont were known for "institutional advertising," making ads and sponsoring programs that showcased the morality of big business and American capitalism. Rather than producing sales, these sponsorships aimed to produce a certain form of citizenship and corporate governance, as well as an esteemed public image for companies or whole industries.[121] At the same time, these two firms stood at the forefront of advertising technoscience and its culture of optimization. This aspect of their identities fixated on the efficiency of marketing processes, measuring return on investment with a "profit yardstick."[122] But with both faces of their split personalities they practiced politics by other means. The political economy of US media bestows on advertisers a responsibility to judge and fund productions of public culture; taking advantage of computers and OR/MS, a part of the industry that executes those judgments learned to perform its responsibility as an objective, rational calculus centered on marketers' private values, while the industry overall remained passionately committed to reproducing what Zygmunt Bauman calls "a society of consumers."[123]

In another interesting irony, agencies sometimes stressed that optimization actually shifted media buyers' focus *away* from ratings "numbers" and toward audience qualities and "editorial values."[124] In other words, these tools directed media buyers to consider each audience segment's propensity to consume and each media outlet's effectiveness in accessing and influencing the most valuable people. *Don't look for the cheapest or largest audience; look for the combination of audience profile and media vehicle to satisfy the marketing objective*—that was the pitch. It was a handy device for agencies because it discouraged clients from slashing their spending and instead urged them to trust these technologies to squeeze more efficiency from their budgets. It is ironic, however, because modeling techniques quantified those editorial values and consumer profiles so that they could be calculated to optimize an objective function. These procedures flattened media into variable inputs for maximizing rated exposure or cost per prospect obtained.

While diverging from a simple "buy by the numbers" routine, the model-based rule of calculation aspired to enumerate *everything* that analysts deemed important to marketing objectives or decision situations. BBDO's research director admitted as much when responding to a question about whether LP might reduce the "ratings battles" among broadcasters. "I question very seriously whether we will ever be able to take out the numbers," he said. "However, we will probably break down audiences from sheer numbers into *kinds of people*: the times of day they watch, their demographic characteristics, the products they buy, etc. If anything, you will probably see a greater demand for numbers but of a more specific kind, more pertinent to the problem's solution."[125] OR/MS formatted consumers and advertising processes in such a way that, as measurement and computation expanded, transactions could be executed by way of numbers that signaled, for example, the probability of a certain behavior or the expected profitability of a potential customer. The initial maneuvers detailed here remained within a demographic mode of knowing and transacting, but they began to set up material and cultural conditions for imagining progress toward new ways of packaging commodified attention and behavior.

Overall, media models represented a "rationalization of audience understanding," to use Philip Napoli's phrase.[126] But it was a contradictory rationalization. Math men remade media and consumer audiences into properties that could be acted on with management technique and impersonal decision rules. But OR models also admitted more complex variables into the

calculations—variables that were difficult or sometimes impossible to measure reliably. By trying to solve one problem—accounting more precisely for the value of advertising opportunities—the business created new logistical and epistemological problems for itself. Optimization complicated media selection, in comparison to simply buying exposures by ratings numbers, and it created openings where subjective assumptions and judgments could be reintroduced under the cover of a rational edifice. This contradiction remains active in adtech. Programmatic advertising enacts and commodifies rationalized units of audience attention or behavior via machinelike decision systems, but those decisions accommodate many hard-to-know variables and thus permit unaccountability to hide among seemingly objective facts and figures.

CONCLUSION

Operations research and management science helped invent digital adtech. Experts and techniques that responded to corporate pressure for efficiency and rationality began to command legitimacy and power within advertising's organizational cultures. OR/MS specialists at consulting firms, large corporations, major advertising agencies, computer and information service providers, and prestigious universities set out to formalize marketing processes and relationships. Model building implied and manifested particular orderings of the world—what was important, how things fit together, who was worth what, which outcomes to expect, how to intervene and adapt. And it required analysts and decision makers to assign explicit values to whatever they wanted to predict and control. Market segments and media vehicles were scored in terms of their value to advertisers, and these scores affected the flow of money through ad-supported media industries. This culture of optimization set a lasting tone for adtech's discrimination engines and created conditions for the eventual decoupling of media content and advertising placements, a hallmark of programmatic advertising. Optimization models did not sever the link between media content and advertising on their own, but they made concrete in new ways the desire to configure advertising investments around marketing objectives.

Here, as in the previous chapter, we find technical experts trying to organize reality to make it calculable, predictable, and manageable via the know-how they claim to command. The emergence of optimization models, like

other forms of rationalization, was about not only technical improvements but also a particular rhetoric of decision making and expert authority.[127] This mathematical elite acted like what Jenna Burrell and Marion Fourcade call today's "coding elite," vowing to eradicate irrationalities and inefficiencies from an industry by reforming its traditional habits through algorithmic designs.[128] Operations researchers framed media selection as a formalized science of decision making and translated media decisions into optimization problems with mathematical solutions. The management of advertising investments began to look like a sequence of information processing and analysis tasks that could be delegated to computer systems and the specialists who used them. Formalizing, automating, and optimizing decisions about advertising distribution are the essence of what adtech does today.

Though draped in dazzling ornaments of space-age technology, optimum seeking did not really upend the existing logic of media selection. Rather, it aimed to advance industrial practice closer to some of advertising's ideal purposes and priorities. Peter Drucker might have described this as a form of automation. The "basic automation question," Drucker explained in 1955, is this: "what is the logic of the process and how do we organize it according to its logic, rather than according to tradition."[129] Automation, here, is the recognition of an opportunity to refine or intensify the social relations contributing to some objective function. This is precisely what OR/MS claimed to be doing—aligning advertising investment decisions with their underlying logic. Optimization models would weed out the biases, inefficiencies, and irrationalities lurking in traditional (nonautomated) practices, revealing value that was ripe for the picking.

What Drucker calls automation is thus an affordance, the perception that a technology or technique can be used to organize a system or process more rationally. Caitlin Zaloom explains that this work of rationalization "is never quite finished: there is no end to the process of producing the conditions of formal rationality."[130] So it is with optimization. Optimization is a promise of improvement, and even as it identifies the *one best choice*, the promise is never finally satisfied. Every "disruption" implies the potential for a new optimum. Dreams of optimizing advertising are recurring dreams. They surface over and over, whenever changes, or even perceptions of change, invite well-positioned actors to claim that *now* it is possible to progress toward perfection.

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