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guest editor
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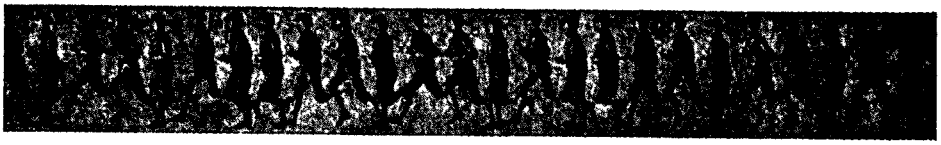

Conceptually it is easy to create a management information system. All you need to do is install a computer (even a small one will do), put all the company information inside it and place a terminal device in the managers' offices. The problems of sorting and retrieving information are not insurmountable and hence there is, theoretically at least, no reason why the system should not be successful.

However, it doesn't quite work that way. Despite the speeches extolling the advantages of an information system, and despite the papers, articles, books and university courses on the subject, little headway has been made in actually installing honest-to-goodness management information systems in companies. Rare is the manager who views the computer as something he personally will use throughout the day to get information on demand in a form in which he wants it and when he wants it. More common is the manager who likes to get voluminous reports from the computer; not that he intends to use them, but if his boss should call and ask for certain information, the subordinate feels he must have rapid access to the data to avoid appearing to be out of touch. It is interesting to speculate on how much this defense mechanism costs a large company over a year.

Senior managers seem to be able to ignore the computer. They can, quite successfully, claim that the decisions they make are not sufficiently repetitive for the computer to be of much help. Or, they can say that the information they require comes mainly from outside the company. They do, fortunately, continue to pick up the tab for the computer but the justification is mainly for the use of the machine for data processing, engineering, production control and other routine or problem solving activities.

And yet the articles we read remind us that the real payoff from a computer will result from improvements in management which it makes possible and which are so difficult to evaluate. Computer manufacturers are quick to provide us with slide presentations showing senior management groups wisely watching a cathode ray tube on which is portrayed company information, usually in graphic form, and then wisely making a decision based on what they saw. Such a process is coming in the real world—but it is not here yet. Senior managers

today do not make important decisions based on what they see on a cathode ray tube and the main reason is that they don't know how. They have not yet learned how to live in a world of complete information and as a result continue to rely on written reports, verbal presentations, opinions of subordinates and plain old fashioned hunch (often called judgment). But that's not the only reason. Another reason is that the people responsible for designing data processing systems in a company are rarely aware of what the senior executive's job really entails. They find it difficult to understand why the senior manager cannot simply prepare a list of his information needs. They are vexed by the fact that two executives might have entirely different information needs to make the same decision. And they are perplexed by the fact that there is no such thing as *the* cost of an item in a company. The correct amounts to add to get *the* cost of any item varies according to the use to which the cost is to be put.

In an effort to make managers familiar with computers most hardware manufacturers provide courses which teach them a little programming and perhaps even let them press the buttons. But there is a dearth of courses which the manager can take which actually show him how he can change his style of managing to take full advantage of the power of the computer. No doubt the reason for this is that very few people can tell him.

Senior managers who have made a sincere attempt to develope a complete information system report that it is a frightening experience. It requires the manager to examine, and invite others to examine, his job in great detail. It requires him to think, in a way that nothing else ever has, about what he does and why. He must spend much more time in planning than he previously did and as a consequence, must delegate more authority. The net effect is a substantial change in the way things are done at the top level. No longer need he call a subordinate for information or even an explanation; these, he can get by pointing a light pen at the appropriate symbols on a screen. He has to judge these subordinates less on the basis of their memories and more on how they manage.

Needed are courses, probably at the university level, which managers can take and which teach them how to live in a world in which complete information is available to them when they want it and how they want it.

Nor are the computer systems people spared from change. Once a company installs a management information system with terminals available to all managers, the need for internal routine reports disappears. Hence, the systems men have to concentrate on providing adequate machine storage, fast sorting and a system sufficiently flexible that any manager can call for any company information in any form and at any time.

Today, the computer is celebrating its 25th birthday; as guests at its party it has finally invited the senior managers. No doubt they will have a happy time together.

Andrew Grindlay
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Letter to the Editor

We would like to comment on Donald G. Morrison's article, "Measurement Problems in Cluster Analysis," which appears in this issue, and on Abe Shuchman's letter (Letter to the Editor, *MS*, June, 1967) as they bear on our article, "Cluster Analysis in Test Market Selection" (*MS*, April, 1967).

It is the common fate of most expository papers (ours included) that the authors do not say all they could—or, perhaps, even all they should—about their topic. Dr. Morrison has made two basic points: (1) the extension of distance measures to cover the general obliquity of axes; and (2) the use of a priori weighting measures (his lambdas).

With regard to the first point, our reason for stopping with the first two factors was, as Dr. Morrison surmised, expository. We merely wished to show the representation graphically. But, as a matter of fact, there is some disagreement among "cluster analysts" as to whether one should use the general obliquity measure (in which "unreliable" factors may appear). Moreover, we could have gotten results similar to the original analysis had we first extracted all 14 components and weighted the factor scores by the square root of the latent root of each component.

With regard to the second point, just for the record, our program *does* include provision for the assignment of a priori weights. Here again in an expository article we chose not to comment on this particular problem.

Although Dr. Morrison's points are not new, our paper presented no new methodology either. We think that Dr. Morrison has raised two important points and that his elaboration of them should prompt further work in this interesting area.

Unlike our reply to Dr. Morrison's comments, we have little to say constructively about Dr. Shuchman's remarks. It is one thing to be faulted on grounds of "promising too much"; it is another to be called to task when one has tried to discuss limitations of the techniques.

We corroborate Dr. Shuchman's surmise that our intention was "to call attention to a group of diverse techniques which can be subsumed under the title 'cluster analysis.' " From that point on, the relevance and rationale for the intensity of his remarks elude us, except that he apparently confuses "could be" with "will be."

The one *statistical* recommendation that Dr. Shuchman makes (in which he cites D. F. Morrison's *Multivariate Statistical Methods*, McGraw-Hill, 1967) is blatantly wrong. If he rereads that section of Morrison's book (especially page 141) he will note that within group versus between group tests are relevant only on group assignments made according to *external* criteria—not clusters developed *from the data itself*. Ironically, his suggestion seems to imply that clustering techniques are *less ad hoc* than we think (and said) they are. Frankly, we are grateful that the referees of our paper did *not* suggest the application of the kinds of hypothesis tests that Dr. Shuchman's year-long study of the area leads him to advocate.

But enough of answering diatribe with further diatribe. Perhaps only time—

and further research, not inaccurate pontification—will tell whether cluster techniques turn out to be "useful." In the meantime we are sadly reminded of the phrase: "We tried to build a dog house. Already you want to throw a convention in it!"

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Letter to the Editor

Professor R. M. Adelson has recently pointed out (Letter to the Editor, *Management Science*, April, 1967) that Donald Farrar's decision criterion (*The Investment Decision Under Uncertainty*, Prentice-Hall, 1962) leads to results inconsistent with utility theory. In this letter it will be shown that the difficulty arises through an error in Farrar's analysis and that a correction of Farrar's work yields a modified criterion which does not fail under Adelson's counter-example. A discussion of Adelson's counter-example in terms of Rudolf Freund's decision criterion ("The Introduction of Risk into a Programming Model," *Econometrica*, Vol. 24, No. 3) is also presented.

Farrar proposes a quadratic utility function exhibiting diminishing marginal utility. Thus the utility function is given by

$$U(x) = a + bx - cx^2.$$

The expected utility of an investment with uncertain returns is given by

$$\begin{aligned} E[U(X)] &= a + b\mu_X - cE(X^2) \\ &= a + b\mu_X - c(\sigma_X^2 + \mu_X^2). \end{aligned}$$

A linear transformation yields

$$E[U(X)] = \mu_X - A\sigma_X^2 - A\mu_X^2.$$

Farrar, in his analysis of the same problem, derived

$$E[U] = \mu_X - A\sigma_X^2$$

which is incorrect. The error made by Farrar lies in his failure to recognize that the "linear" transformation he performs on page 21 of his book is in fact non-linear. Farrar, after proceeding via a Taylor series expansion, derives

$$E[U(X)] = U(\mu) + \frac{U''(\mu)}{2}\sigma_X^2.$$

The expression $U(\mu)$ is itself not a constant since it will depend on the particular μ of the investment under consideration. Furthermore, this expression is non-linear and thus Farrar's simplification of $U(\mu)$ to μ by a "linear" transformation is incorrect. If $U(\mu)$ were a constant under a linear transformation we could obtain the patently unreasonable criterion

$$\max E[U(X)] = \frac{U''(\mu)}{2}\sigma_X^2.$$

It is a matter of simple algebra to demonstrate that the substitution of the correct formulation of the utility of an investment (under the quadratic model) into Adelson's three investment counter-example does not lead to a violation of the axiom he describes. We have investments I_1, I_2 and I_3 with

$$U_1 = \mu_1 - A\sigma_1^2 - A\mu_1^2$$

and

$$U_2 = \mu_2 - A\sigma_2^2 - A\mu_2^2.$$

Investment I_3, which gives I_1 with probability p and I_2 with probability $(1-p)$, yields an expected utility

$$U_3 = pU_1 + (1-p)U_2$$

consistent with what we would expect.

The writer is indebted to Robert Hogg and John Birch of the Department of Statistics, University of Iowa, for their invaluable suggestions with respect to the analysis for Freund's criterion. Freund begins with a utility function of the form

$$U = 1 - e^{-ar}$$

where a is a constant and r is a normally distributed random variable measuring net revenue. Taking expectations, it is shown that expected utility is given by

$$E(u) = 1 - e^{(a^2\sigma^2/2)-a\mu}$$

Maximizing expected utility is then clearly equivalent to maximizing

$$\mu - \frac{a\sigma^2}{2}$$

which is of the same form as the Farrar criterion.

A key difference between the Farrar formulation and the Freund formulation is that in the latter case the functional form of the random variable is specified and is assumed to be normal. Adelson's counter-example requires the construction of an investment I_3 from a lottery on two investments I_1 and I_2. If returns on I_1, and I_2 are normally distributed with distributions f_1 and f_2, the mixed distribution of returns on I_3

$$f_3 = pf_1 + (1-p)f_2$$

is *not* normally distributed and thus violates an assumption of the Freund model. The Adelson counter-example is thus not relevant to Freund's criterion.

Bertram Schoner
University of Iowa

Letter to the Editor

In an effort to understand our war on the people of Vietnam and our other efforts at dominating the world, I have been doing some reading on the history of the Roman Empire. Although I am not sure the reading has been useful for this purpose, I did come across the following passage which struck me as being of particular relevance for the problem of research in management science.

> Unfortunately, mathematical speculation, in which the mind forever moves without coming up against the obstacle and the control of facts, presents analogies to metaphysical speculation. Its methods and discoveries throw the mind into an ecstasy which may even become a cerebral disorder. Discovery by the mere force of reasoning leads to the belief that through juggling with formulae one may penetrate the secrets of nature and so subject them to man's will. Thoughtless admiration for mathematics keeps up or reintroduces the mentality of magic.

The passage is from Ferdinand Lot, *The End of the Ancient World and the Beginnings of the Middle Ages* (p. 167 of the 1961 Harper Edition).

Myron J. Gordon
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Letter to the Editor

This is a parable of futuribles.

I am sitting in my office in the suite of Dillman, Green and Co., member of the New York Stock Exchange, this day in 1980, pondering over my study of a particular company. I am a security analyst, and have a good technical background, having received my degree in systems engineering in 1970, and having some years experience since then in the computer industry in the development of both hardware and software, and also in the analysis of business management. I received my certificate as a security analyst a year ago. As you might expect, I specialize in companies in the computer field and also fields such as cybernetics and systems planning.

The company I have been studying is the Adaptational Computer Corporation. It was started fifteen years ago and grew slowly at first, but phenomenally in recent years—yet I don't know whether I should recommend it for purchase, even though this company has captured a major share of the adaptive computer market, and has branched out into other industries. Its earnings have increased rapidly and the stock has risen to a very high price. I am particularly interested in some of its suppliers, in which it owns many shares of stock.

The computers are not large. In a space no greater than a standard five-drawer filing cabinet, there is far more memory and computing capacity than in a room full of the famous IBM 360-series computer, with all its peripheral equipment,

that was so popular ten years ago. In fact, this is the only company that has made really serious inroads into the IBM position of dominance in the computer industry.

While it is desirable for an analyst to interview some of the officers of a company, it has not been possible for me to make contact with any of them. I have had brief telephone contact and some correspondence, and have read reports and data which they have sent me. I have rather complete information on the company as of several years ago, but since then it has been increasingly difficult to get information that I could comprehend. The style of the reports has become formal and stylized. By interviewing former officers of the company I have received a good deal of the information that is written here.

Looking back, one of the most distinctive features of the company was the practice it adopted of "taking the bull by the horns" with regard to a problem which arose several years before their founding. This problem was that improved computers were being announced by different companies at frequent intervals. A customer would have just decided which computer to buy, after considerable study by his staff, when another new computer would be announced. Of course, the new computer would not be ready for delivery for about two years, and because of a big backlog, the customer could not expect delivery for another year. Then, an additional shakedown period would be required for learning to use the system, even though some experience had been obtained with a model in the manufacturer's plant. The question was whether to take the first computer chosen or to wait for the new computer that had additional features and perhaps lower cost.

The solution of the Adaptational Computer Corporation was straightforward. It brought out a new computer every year (like our automobile manufacturers). As soon as the computer was completely tested with a new program that could take full advantage of all its features, it was installed in the design laboratory of the company. The engineers and program designers used it to start design on the next year's computer. Proceeding in this manner, year after year, the company is now in production of its fifteenth-generation computer, and well into the design of the sixteenth-generation one. The price has varied, going up and going down, but on the whole rising at a rate somewhat less than the general increase in price level due to inflation.

Placing a new computer on sale every year causes no more anxiety to a prospective customer than do the new 1980 cars. There is a healthy market in used Adaptational computers. Since a customer can sell his old computer at a reasonable markdown, he can buy a new model at not too great an expense. The policy of not leasing computers was adopted from the start, so there has been no problem about replacing previous-generation computers held by lessees. This policy has also insured a good position with the Government, which has taken a firm position against leasing.

As computers were built with more solid-state devices, reliability improved and less servicing was necessary. Service was never extended for more than a year; the customer used his own or an outside service organization, much as

independent automobile repair shops service automobiles. As time went on, the computers became smaller and smaller. With rapid air freight, it became possible to offer a one-day replacement service. A customer could have a defective unit shipped to the Adaptational factory while the company shipped out a replacement. Actually, the need to do this now is very rare because reliability is so great.

Adaptational has always been automation-minded. It applies operations research techniques to all its operations, including those of management. Marketing surveys are tabulated and analyzed on the newest computer with the latest adaptive program. Extrapolations are made of customers' requirements for each next-year computer, so that the most relevant improvements can be incorporated. Inventory became completely computer-controlled at an early date. Purchasing was made automatic with the assistance of data telephone lines. Requests for quotations are composed routinely on the computer when the inventory falls below calculated threshold levels; they are sent out on the wire lines to suppliers. Quotations are compared when received and orders are placed immediately on the same lines to the suppliers, who meet the specifications at the lowest price. Accounting has been completely computerized. However, instead of using standard accounting principles, superior methods of measuring financial status are employed, using adaptive programs. These have been improved every year. Shipping and receiving have been completely automated. A large sales staff was built up during the company's first eight years, but the company was able to reduce this staff greatly, keeping close contact with the customer with sales literature through the mail and by advertising. A good technique of composing the ads by computer was developed on the basis of information from the market surveys.

The company is financially sound (at least, as far as one can tell from published financial statements). The number of publicly-held shares has decreased greatly in recent years. The company has therefore become ineligible for listing on any of the stock exchanges, and is no longer compelled to publish financial statements, although it has continued to publish them. It has invested in other companies, and by using sophisticated computer programs, appears to have done well in its investments. I don't know if the company controls any other companies; however, there is no reason why it may not have controlling interests in some other companies.

Of course, at the heart of its success in bringing out a new computer every year is the fully automated production line, which is under computer control. As I said earlier, the design of next year's computer is accomplished by using the latest computer off the production line. I should also add that at the end of the production run for the year, all production is shut down and the latest generation of computers installed to replace the old.

With the knowledge of solid-state technology accomplished in recent years, and with the improvement in information file and retrieval, it has been possible to computerize and automate development as well as design. Of great advantage has been automated purchasing. Specifications on new developments are made

available to Adaptational in coded form on the wire lines by companies that have highly organized information filing and retrieval systems. This permits more rapid use of information than by the method of reading advertisements, so that the company can effectively take advantage of development done by other manufacturers.

As a result of the financial optimization elements of its adaptive programs, the company began, some years ago, to buy up publicly-held shares of its own stock. This has bid up the price of the stock to $20,000 per share with no shares offered. I suspect that no shares are available, and that the company owns all its own stock, and this is why I am especially interested in the companies in which it has large interest.

The only significant irritation that Adaptational seems to have produced has been in its dealings with its former personnel, especially lower-echelon workers. Some resentments appear to have been worked out by throwing stones at the few opaque windows in the building. When detected by the automated alarm system, these vandals were driven off by the Adaptational guards, who were incommunicative upon interview. The only information elicited was that they were well-paid to do their job, receiving their checks by mail, with annual increases.

In some small measure, worker resentments have infected citizens of the town. However, upon attempts to raise the town taxes on the company property, legal representatives of the company made a conclusive defense by pointing out that the assessed value of the property is in as high ratio to the market value as any other property in town. Since the company is a legal entity and protected by the same laws as any other corporation, there seems to be no legal loophole through which the company can be attacked or sued. It pays its income tax in full, and while it has a large share of the adaptive computer market, the market is growing, so the company can continue to grow without being subject to any kind of anti-trust legislation.

Presumably, the company can continue to evolve as its computers do. It has become an interesting organism, not only reproducing, but evolving and adapting itself to its environment in the framework of our laws and our economy. We might ask whether the company and its computers might become too adapted to our economy and be unable to adjust to sudden shifts. With only one year to a generation, however, it would seem able to adjust to shifts. We don't know anything about the contents of the computer programs of the in-plant computers. I don't think that anyone can say that he really understands the adaptive programs that are available from the company, so it is a little hard to estimate the adaptability in its "gene pool."

A computer factory utilizing computers for design, production, and management purposes is most interesting. While computers are used widely in many industries for these purposes, they do not have as high a degree of evolutionary potential. These industries do not possess the computer reproductive capacity.

What bothers me most is the rumor that Dillman, Green and Co. is controlled

by Adaptational. I've worked here for years and I'm sure that Mr. Dillman would want me to make an honest appraisal of the companies in which Adaptational has large interests. I wonder why I can't make up my mind?

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