Ricocheting through the wires on our cover are the pellets of a very special pinball machine; it illustrates the theory of probability, predicting the distribution pattern of all the balls when they come to rest. For more on probability, a theory everyone can use, see page 2. Below, Charles Eames (left), designer of the machine, surveys an early model of the mathematics exhibit he created for the California Museum of Science and Industry. For more on Eames, see page 7.
A MEMO TO OUR READERS:

When we say that some event is a probability, we are usually trying to predict the future. When we say that something is a statistic, we are usually trying to describe the past. For instance, before a novice skier plunges down an expert slope he's merely a probable accident victim. After he has been carried away from the bottom he is a statistic.

Probability and statistics have always had this close relationship. Statistics, as records of past events, give us confidence that the future will remain consistent with the past. The insurance company that carries a policy on your life, for instance, knows that during each year for which it has records, so many men per thousand have died at your age. Relying on this figure, it can set your premium high enough to cover necessary payments to survivors, yet low enough so that you can pay it. Of course, the insurers cannot foretell which men from your age group will die. Luckily, no one has that power.

It is always the most interesting questions which can be answered only by "probably," or "maybe," or "perhaps," or "sometimes." Will this year be prosperous for you? Will your children live in peace? Will justice reign everywhere? Will freedom spread or diminish? No one can say for sure, and the notion of probability offers us the only sound way to answer these puzzles. For an illuminating discussion of the theory, we recommend to you an extraordinarily lucid and informative article on the subject, beginning on page 2. It was written for us by Warren Weaver, mathematician, foundation executive and philosopher. His ideas may profoundly affect your view of life's certainties.

THE EDITORS
PROBABILITY

deals with questions that are answered by

"POSSIBLY" — Will I win the Irish sweepstakes?

"SOMETIMES" — Do black-haired parents have red-haired children?

"MAYBE" — If I drop this coin will it come up heads?

"I HOPE SO" — Will Amos Wringer live to 95?
Probability: The Odds Are High that It Affects You

by Warren Weaver

The theory of probability, which evolved from a dice game, can be vastly useful for the everyday business of forming judgments and making decisions. Its applications range from life insurance to telephone traffic problems, all forms of competition and even philosophy itself.

The mathematics to which our youngsters are exposed in high school is, with rare exception, based on the classical yes-or-no, right-or-wrong type of logic. It normally doesn’t include one word about probability as a mode of reasoning or as a basis for comparing several alternative conclusions. Geometry, for instance, is strictly devoted to the classical syllogistic “if-then” type of reasoning and to the notion that any statement is either correct or incorrect. The youngsters are told, in effect, that if you want to reason logically then you must reason that way.

Indeed, it has been remarked that life is an almost continuous experience of having to draw conclusions from insufficient evidence. It’s no good “looking for the hidden assumptions.” They are not hidden. They are simply non-existent. So, drawing conclusions without sufficient facts to lead to a classical logical conclusion is what we have to do when we make the trivial decision as to whether or not to carry an umbrella when we leave home for work.

This is what we have to do when we make the important decision whether or not to authorize the surgeon to operate.

This is what a great industry has to do when it decides whether or not to put $50 million into a new plant in the Argentine.

This is what the Joint Chiefs of Staff have to do when they decide how to distribute our national spending for defense.

This is what our President has to do when he faces a grave decision of international politics.

This is what — God forbid — someone may eventually have to do when a decision is made as to whether or not to push the button that initiates nuclear warfare.

In none of these cases — and, indeed, in practically no other case that you can suggest — can one proceed by saying, “I know that A, B, C, etc., are completely and reliably true, and therefore by the rules of classical logic, the inevitable and unique conclusion is . . .” Does this mean that logic has nothing to offer to the puzzled individual? It does not in the least mean that.

For there is another mode of reasoning, which does not say, “This statement is correct and true, and its opposite is completely false,” but which says, “Gentlemen, there are various alternative possibilities. No one of these is certainly correct and true, and no one certainly incorrect and false.” There are varying degrees of plausibility — of probability — for all of these alternatives. I can help you understand how these plausibilities compare. I can also tell you how reliable my advice is. If you furnish me with a good deal of evidence, then I can give you pretty firm (but still not absolutely firm) advice. If you give me a little to go on, then naturally my advice will be much more shaky. But in all these cases, my advice can give some useful estimate of the comparative plausibilities.

This is the kind of logic which is developed in the theory of probability. This theory deals not with two truth values — correct or false — but with all the intermediate truth values: almost certainly true, very probably true, possibly true, unlikely, very unlikely, etc. Being a precise quantitative theory, it does not use phrases such as those just given, but calculates for any question under study the numerical probability that it is true. If this probability has the value 1, then the
answer is an unqualified yes. That is, probability equal to 1 corresponds to certainty. If the probability has the value 0 (zero), then the answer is an unqualified no. That is, a probability of 0 means false, impossible. If the probability is ½, then the chances are even that the event has an affirmative answer. If the probability is, say, 0.1, or 1/10, then the chances are 1 in 10 that the answer is yes.

The theory of probability, although it had a very rudimentary and fragmentary earlier start, really began rather abruptly just 306 years ago, when the French mathematician Fermat was asked a question about a gambling game.

A die has six faces. If it is accurately made, then, when it is thrown or rolled, one face is as likely to come up as any other. Thus, the probability of throwing a 4 (or, for that matter, any other specified face) is 1/6. This means that in a very long series of throws the face numbered 4 will come up very close to 1/6 of the time. The longer the series of throws, the closer to 1/6 this ratio is likely to be.

When two dice are thrown, a consideration enters which is fundamental to the whole theory of probability, and which at the same time involves rather tricky and careful reasoning. It is easier to think about if we suppose that one of the dice is green and the other red.

When a single die is thrown, there are exactly six things that can happen (i.e., any one of the six faces may come up), and these six cases are equally likely. Therefore, in the long run, any one face will come up about as often as any other face; and that is precisely why the probabilities of the various faces are equal, each being exactly 1/6.

When two are thrown, how many equally likely things can happen? The answer clearly is: any one face on one die can occur along with any one face on every other die. This means there are 36 equally likely cases when two are thrown, the table of these cases starting out and finishing up as follows:

<table>
<thead>
<tr>
<th>Case</th>
<th>Red Die</th>
<th>Green Die</th>
<th>Sum of the Two Faces</th>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<td>2</td>
<td>1</td>
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<td>11</td>
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<tr>
<td>36</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Thus, a sum of 2 can be produced in one way only (Case 1), whereas a sum of 3 can be produced in two equally likely ways (Case 2 and Case 3). A sum of 12 can be produced in only one way. A sum of 7 can be produced in six ways (by throwing a 1 and 6, a 2 and 5, a 3 and 4, a 4 and 3, or a 5 and 2); and these six cases are equally likely. The probabilities of the various sums are equal, each being exactly 1/36.

Every experienced craps player knows that a sum of 2, "snake eyes," or 12, "box cars," are each "one way" points, and therefore relatively hard to make. Each has a probability of 1/36, appears on the average only once for every 36 throws. But a sum of 7 is a "six-way point"; it has a probability of 6/36 or 1/6, and can be expected to occur once every six throws.

Having noticed these simple facts about probabilities with dice, we can now profitably go back to the event which inaugurated the development of the mathematical theory of probability. It seems that gamblers of the mid-17th century were accustomed to bet, with any optimistic customer, that at least one 6 would appear in four throws of a single die. They could, with a rather narrow margin, afford to make this bet, for the odds in favor of at least one 6 in four throws are 671 to 625.

Are you a little curious as to how these particular numbers arise? Let me explain:

Since the probability of a 6 is 1/6, the probability of not getting a 6 on a single throw is 5/6; and of not getting a 6 on four successive throws is (5/6)^4 = 625/1296. But the logical opposite of "not getting a 6 in four throws" is "getting at least one 6 in four throws." And if the probability of any event is p, the probability of its logical opposite is 1 minus p (since the two probabilities together cover all cases, and must therefore add up to certainty or 1). Thus, the probability of at least one 6 is 1 minus 625/1296, or 671/1296; and the odds in favor of at least one 6 are 671 to 625, this being the ratio of the probability for (671/1296) to the probability against (625/1296).

An Old Gamblers' Rule

There was, moreover, an old gamblers' rule which appeared to justify the conclusion that if one could safely bet on at least one 6 in four throws, then one could also afford to bet on at least one double 6 in six times four, or 24 throws. This gave rise to the question posed to Fermat: does the rule apply to this case, and, as the rule would indicate, are the odds better than even of getting at least one double 6 in 24 throws?

The intriguing fact is that the odds are approximately 5086 to 4914 against getting at least one double 6 in 24 throws. However, if one bets on 25 throws rather than 24, then the odds are very mildly (about 5055 to 4945) in favor of at least one double 6.

The reader may well be rather confused at this point. I started out with serious remarks about the training of youngsters, about logic, and about ways of drawing conclusions. And here I have been talking about a rather silly little gambling game which was played some 300 years ago! The game seems — and of course is — completely trivial; and yet the numbers, which approximately give the odds, are rather mysterious. They would be far more mysterious if the odds were stated precisely, instead of approximately; for then, instead of saying "approximately 5055 to 4945," one would have to use numbers of 39 digits each.

I have discussed this problem partly because it was responsible for the real birth of the theory of probability, but chiefly because it illustrates several important points.

First, it is interesting to know that, for a long time after its inception, the theory of probability was largely concerned with gambling games of various sorts. The various systems optimistically designed by gamblers are shown, by probability theory, to be of two basic types: those that have some effect on the probability of loss or gain over short periods of play; and those which have no effect whatsoever. A good
many systems fall in the second category, and falsely appeal simply because of ignorance concerning probabilities. Using a system of the first type, a gambler with large resources has a reasonable chance to win a small amount before being wiped out by losses. But whatever system is used, anyone who keeps on gambling against an adversary or syndicate whose resources are very large compared to those of the gambler, and one whose games give an advantage to the "house" as would of course be the case with any professional gambler or syndicate, is bound to be ruined.

Second, it is important to notice that although the terms of this little gambling problem are perfectly definite and very simple, the answer to the question is not very simple and certainly is not obvious. It is by no means obvious that the odds for at least one double 6 become favorable as the number of throws exceeds 25. If your life had depended on estimating just when the odds would become favorable, would you have been able to guess correctly? The only way to be sure about this estimate is to calculate it by the theory of probability. And this same remark applies to countless other problems, not trivial as this game clearly is, which you might have to face.

The remarkable fact is that one's intuition is often not very good at estimating, or guessing, answers to probability problems. There has been considerable publicity recently for what is often called the "birthday problem." How many persons must there be in a room in order that the odds be favorable — better, that is, than even — that there are at least two persons in the room with the same birthday (day of the month and year)? Remembering that there are 365 separate possible birthdays, some persons estimate that there would have to be 50, or even 100, persons in the room to make the odds better than even. The answer is that the odds are better than even when there are 23 persons in the room. (Unfortunately, this remarkable fact cannot be "explained" in any way which is both accurate and brief. But it can be handled in a rather elementary course on probability and statistics.) With 40 persons in a room the odds are better than eight to one that at least two will have the same birthday; and for the United States Senate, the odds are almost a billion to one.

**Sampling the Universe**

Before proceeding with our main argument, let us consider one more example of the fact that one's ordinary judgment or intuition is not very reliable at times. Everyone is interested in polls. They always involve estimating the composition of a large group (say all those who vote) by determining the opinion of a sample. In statistics the whole group in question is called the "universe." Now suppose you want to consult a large enough sample so that its indication will reflect the whole universe with at least 98 percent precision in 99 out of a hundred instances. How large does this very reliable sample have to be? If the universe numbers 200 persons, then the sample must include 105 persons, or more than half of the whole universe. But suppose the universe consists of 10,000 persons, or 100,000 persons?

In the case of 10,000 persons, a sample, to have the stated reliability, would have to consist of 213 persons. The sample increases by only 108 when the universe being sampled increases by 9,800. And if you add 90,000 more to the universe, so that it now numbers 100,000, you have to add only 4 to the sample! The less credible this seems to you, the more strongly I make the point that it is better to depend on the theory of probability than on intuition.

The trivial games I have described illustrate a third point about probability theory. Certain fundamental aspects of this theory involve only the most elementary mathematics, so that a start can be made in educating youngsters to this mode of reasoning even in the elementary grades. The underlying procedure in probability problems is, in fact, simply to count the cases — all of the equally likely cases, and also the cases that are favorable to the event under consideration. If one is dealing with the tossing of a single coin, then there are only two equally likely cases; or with a single die, 6; or with two dice, 36.

**Why Teach Probability?**

The fact that important and fundamental aspects of probability theory can be dealt with by very elementary means is of great significance in connection with education. For it means that youngsters can be taught the elements of this mode of thinking in the grades of elementary school.

But why should they be taught probability theory? Because it teaches one how to shoot craps or play games? Surely not.

They should learn this mode of reasoning because it is the only type of logical thinking that is capable of producing useful conclusions from evidence insufficient for the older type of yes-or-no-logic; and because it turns out to be the kind of mathematics which, in the final analysis, governs all the basic phenomena of the living and the physical world.

For, although the subject started out with dice, with cards, and with colored balls to be drawn from urns, it soon became clear that the method of reasoning had important application to other fields of activity. In the 18th century, and even earlier, mathematicians began to apply probability reasoning to questions concerning the incidence of disease, the vital statistics of births and deaths, the duration of marriages, etc.

In the last quarter of the 18th century, Laplace laid the foundations for a theory of errors. In the early part of the 19th century, Gauss developed this into a real working tool for all experimenters and observers. Any measurement, or any set of measurements, is necessarily inaccurate. And it is a matter of the highest importance to know how to take a lot of necessarily discordant data, combine them in the best possible way, and produce in addition some useful estimate of the dependability of the results.

The theory of errors made it quite clear that the "true value" of any quantity being measured is a pure fiction. Only the metaphysicists will wish to pursue further the question as to whether a "true value" really exists or not. It is perpetually unattainable, and thus to the operationalist it is simply meaningless to ask whether or not it exists. Even at this early stage it was in fact clear that all our knowledge of the physical world is probable knowledge.

Around the turn of our present century, it began to be clear that probability plays a vital role in the life of every person, in that it governs the procedures whereby we inherit
our individual characteristics from our parents and from earlier ancestors. In fact, all our inherited characteristics are controlled by the so-called genes which make up our chromosomes. When a male sperm unites with a female ovum to form the start of an individual, the set of genes with which this new creature starts life is obtained by a purely chance process, from the set possessed by the male parent and the set possessed by the female parent. This one basic fact at once brings a large part of genetics under probability theory. Thus it is the theory of inheritance for all living creatures.

To these mentioned older fields of application should be added the many more modern examples: in life insurance telephone traffic problems, information and communication theory, which deserves a whole article by itself, game theory, with applications to all forms of competition, including business, international politics and war; modern statistical theories, both for the efficient design of experiments and for the interpretation of the results of experiments; decision theories, which aid one in making judgments; probability theories for the process by which we learn; the Monte Carlo method, which solves otherwise intractable problems by computing out the results for equivalent games of chance; and many more. But even this rich practical usefulness does not tell the whole story. To comprehend the magnitude of the role of probability theory one must consider the nature of the present view of the physical universe in which we live.

By the beginning of the 20th century almost all of us were completely sold on deterministic, mechanistic science. We were wholly caught in the inexorable and generally successful machine of simple and direct cause and effect. The logic of yes and no seemed to rule all of our lives.

For centuries there had been available the indications that more flexible and more widely applicable methods of thinking could be worked out. The gamblers had started it. The astronomers and others concerned with the attempt to make precise measurements, and thus concerned with the inevitability of errors, had added a great deal to the story. The actuaries had seen how individual uncertainties can add up, when large numbers of cases are involved, to dependable behavior. The social scientists had begun to speculate whether this sort of mathematics was not well adapted to the vagaries of human behavior. The mathematical statisticians were just beginning to work out ways of obtaining and of characterizing the judgments which can be based on data insufficient for processing by means of the classical logic.

And then physics finished the story. Physics finished it during the quarter-century from 1900 to 1925.

Can a Stone Drop Up?

Modern physics says that our confidence that a stone will fall when we drop it is just like (although much stronger than) our confidence that the million clients of a life insurance business will die in an orderly manner, almost exactly so many each week. If the "stone" were composed of only one atom, or one elementary particle, then you would be extremely uncertain of whether, when "dropped," it would fall, or rise, or jump out sideways: just as a life insurance company with only one client would be very uneasy about its reserves. The stone has billions upon billions upon billions . . . of elementary particles; and hence its over-all behavior averages out so dependably. Strictly speaking, every client of the Metropolitan Life Insurance Company could drop dead tomorrow. Strictly speaking, a stone, when dropped, might rise rather than fall.

Water boiling furnishes a similar example. The population of water molecules is so vastly numerous that "the statistics are regular" and the kettle almost always boils when put on a hot stove — "always" meaning every reliably observed time so far; but with the reservation that once in a billion, billion . . . times it might freeze, rather than boil.

The position of modern physics, in fact, is simply this: that all the individual events (and these, by definition, refer to the behavior of one, two, or a very few elementary particles) are ruled only by probability laws. You cannot say what an electron will do. You can only say what it will probably do.

**Probability and the Practical World**

Do not let your familiarity with stones, and your lack of acquaintance with electrons, lead you to be indifferent about this situation. This isn't a fancy detail. This is it. The whole physical universe, au fond, obeys the laws of chance. The order which we ordinarily observe in the universe is simply the result of the fact that we are normally concerned with large-scale phenomena — with experiences in which what we observe is the average of almost countless billions of elementary events. The macroscopic physical world we see with our senses — even the slightly smaller one we see in a microscope — is in effect a life insurance company with billions upon billions of clients, so that the number of deaths per day, or per second, is a perfectly regular quantity. Underneath all this superficial order, however, is chance.

On the view of modern quantum theory, it is not only true one can predict only the probability of various outcomes: actually the situation is still more elusive. For we now know that it is in principle impossible for us to have precise and complete knowledge about individual events. If you are curious about the position and velocity of an electron, you can make improvements in your measurements of the former, but always and inescapably at the cost of the accuracy of the latter — or vice versa. You can't know both as accurately as you desire. The point is not that this is hard to do: the point is that it turns out to be impossible. And hence the deterministic dream of Democritus, Hobbes, Spinoza, Descartes and Laplace collapses. Heisenberg finished all that when he said, "The question whether from a complete knowledge of the past we can predict the future, does not arise; because a complete knowledge of the past involves a self-contradiction."

So now it has become clear that the logic of probability is not confined to the casino, nor to the computing laboratory, nor to the mortuary records. It could be vastly useful for the practical, everyday business of forming judgments and making decisions. I say "could be." For we have not as yet had the sense to teach this fascinating subject in the schools, nor the wit to incorporate it into our everyday habits of thought. But it is, in the last analysis, the kind of logic that controls the universe in which we live.
A Visit With Charles Eames

We call on the noted designer-toymaker-educator in his California studio and get an inside view of the special mathematics display he has just created.

Charles Eames is best known as a designer of chairs, but he is even more famous in industrial and government circles as an extraordinary and gifted practitioner of another, newer art—the art of communication. As practiced by Eames, and a few others, communication is the integration of all the visual and auditory arts in effectively conveying basic messages about science and society to mass audiences.

Eames's early experiences proved excellent preparation for this complex activity. Before he started professional life as an architect, he was thoroughly familiar with the basic art of building. An interest in the furnishing of buildings led him to investigate the possibilities of plywood. In World War II this interest in plywood was put to work for the Navy, resulting in light, comfortable splints for the wounded and huge fuselages for gliders. Shortly after the war, Eames was able to launch his famous molded plywood chairs. He has designed exhibitions, theatrical and motion-picture sets, directed Hollywood films, and made his own experimential films on shoestring budgets. These films have been closely related to one of his continuing preoccupations—teaching. To Eames, teaching means giving to people of any age the tools of understanding that they can use.

Today, in the course of his work, he is apt to call on his experiences in unpredictable combinations. Recently, Eames logged a series of typical activities. In one week he lectured to a class of art students; he personally narrated, edited and cut a film on education; he talked to a Los Angeles high school student body about design. He worked on a major exhibition about to be permanently installed in a Los Angeles museum; he wrote, directed and produced two short color films as part of this work. He worked on preparing the official United States science exhibition at the "Century 21" exposition to be held in Seattle in 1962. This display, housed in its own building, will use a new motion picture technique dramatizing science's role today and tomorrow to a lay audience. He also worked on an important development for the New York World's Fair of 1964. With his wife Ray, his full partner in their design business, Eames then went to New York to receive the first annual Kaufmann International Design Award, given for "an outstanding record of achievement in the practice of design."

As descriptions of a man at work in so many creative media, the words designer and architect assume new values. The sense of structure they connotate is, however, the basic theme of all Eames's work, whether the structure of a product, a film or an exhibition.

The latest achievement in the Eames career is a program of exhibitions, films and other devices called MATHMATICA, A World of Numbers and Beyond. Its first section, a huge and brilliant display, opened March 24, 1961, in a new wing of the California Museum of Science and
Industry, Los Angeles. An expected 1,000,000 people each year will visit this cooperative venture which fuses Eames's imaginative design, IBM sponsorship, and the museum's experienced services.

To learn something about this adventurous foray into popular education, we recently visited Charles Eames at his shop in Venice, California. He and his crew, 16 young jacks-of-all-skills, work in a plain, one-story, white-painted, brick building about three blocks from the Pacific Ocean—a converted garage. There is no sign or nameplate on the front; only the street number. The building's anonymity is deliberate. Eames likes to protect his privacy from those who might take to dropping in. "It is not entirely an accident that all our clients are east of the Mississippi," he says.

The reception room of the Eames workshop gives the visitor a sense of the special Eames blend of business, design and delight. A secretary sits at the reception desk, a low, light, heavy-laden structure designed, like the chairs, sofa and table, by Eames. These are grouped around a colorful, hand-painted photographer's backdrop, a souvenir of a trip to India, a bit of pure pleasure.

Eames then enters. He speaks in a soft voice, slowly; smiles light his face easily and frequently. A bow tie, a Madras shirt, tan corduroy trousers, close-cropped hair, indicate a casual but collected personality. As the day goes on we see his most common moods are amiability and enthusiasm.

We asked him to tell us the purpose of the mathematics exhibit, on which he and his crew had been working for more than a year.

"To suggest," says Eames, "the richness and variety of mathematics, so that visitors will forget any preconceived notion of mathematics as a dry, boring subject, limited to the manipulation of complex numbers, we want to free people's minds to see mathematics as the art of building relationships, the art of constructing abstract models of situations.

"If the whole of mathematics were a mile, what you learned in high school would only be the first inch. We will be happy if we can give a few clues to the excitement and beauty that make up the rest of that mile."

The exhibits meant to do this were taking shape under the high-peaked ceiling of the shop spaces. On one table was a model of the whole exhibition as it would be installed in the museum. All around were full-scale mock-ups of individual exhibits, entire equations in three-dimensional form. A large wall panel was devoted to examples of basic mathematical concepts, shown in the regular patterns of snowflakes or crystals and precise graphic devices developed by mathematicians. A collection of five active, colorful machines is devoted to as many major areas of mathematical activity; by simple operations a visitor to the show will be able to demonstrate each basic kind of activity to himself.

Spread around the studio, in every stage of development, were machines, electronic devices, optical setups, scale models, photo blowups, motion picture sets, and a full-size mock-up of an 11-foot-high, 50-foot-long History Wall — words and pictures devoted to the mathematician in modern times.

The History Wall reveals Eames's way of working. Before developing any displays, he dug deeply into the history of math, consulting mathematicians and studying a wealth of available explanatory material. He and his staff spent months choosing basic ideas — suggesting many, discarding many. For his own guidance, as he went along, he began to organize the mass of documentation into a large wall chart, which showed, from left to right in chronological arrangement, the great mathematicians, their important ideas and their dates, from the 12th century to the present.

"With each mathematician's portrait," said Eames, "we put down a professional description of his ideas and biographical notes about the man.
Much of mathematics has the appeal of magic...some of it really is—pure magic.

In Eames's model of the Moebius ring (left), a traveling arrow runs around the strip. "If it makes one wrong turn," he says, "it will disappear forever—into the fourth dimension."

Soon, in order to keep relationships clear in our minds, we began to fill in information about the world each man lived in, the great events around him. It ended up being much more than a tool for us. It became one of the biggest and most useful features of the show."

One display, for example, illustrates the concept of probability. It is 12 feet tall, a giant, upright pinball machine. The basic idea behind it goes back to Pascal in the 17th century—an example of the careful, scholarly research conducted by Eames and his special math consultant, Professor Raymond Redheffer of UCLA. When a viewer sets the "probability machine" in motion, thousands of half-inch nylon balls ricochet (with sound) downward through a wire maze (see cover of this issue) and fall into a series of channels below. At the end of the "distribution cycle" the balls have fallen in the channels according to a predictable curve that is outlined on the front of the machine. The predicted curve compared with the results of his own actions shows the viewer that while no one can predict the final position of any one ball, the theory of probability can accurately predict the distribution of all the balls as they come to rest.

Another large, odd shape proved to be a famous mathematical curiosity, becoming more and more valuable in today's scientific research, the Moebius ring. This closed, twisted band has only one continuous surface, a fact which seems to defy logic. In Eames's model, a traveling arrow runs around the strip, magically proving to even a casual observer that the ring really has only one surface. "If it makes one wrong turn," Eames says, "it will disappear forever—into the fourth dimension."

Many devices Eames wanted to use didn't exist when he started building the show; he was forced to invent them. In the course of solving larger problems, Eames and his staff have invented some ingenious gadgets such as a sound-motion-picture projector that fits, screen and all, into a case about the size of a portable typewriter. When we asked Eames if he had patents on his inventions, he brushed aside the idea. "Energy spent on patent routine is like energy spent trying to get money from foundations...If you put the same energy into work on the project itself you'll be way ahead."

Eames enjoys nothing more than the challenge of solving communications problems crisply and dramatically. One such problem was: how to give a museum visitor maximum mathematical information with minimum distraction. His solution: peep shows. Unlike those in a penny arcade, they present the observer with two-minute, animated color films elucidating complex mathematical concepts such as symmetry or functions. Each peep show has a specially developed feature—a set of ear pieces which project from the front of the box and surround the viewer, isolating him from the noisy room. The six, two-minute peep shows continue the presentation of basic math areas begun in the work-it-yourself models. "Two minutes," says Eames, "is a delightfully short time in which to state a mathematical notion—from a standing start. We hope that it is short enough for the viewer to push the button again if he didn't get it the first time."

The notion had been growing on us, as we inspected the displays, that what Eames was building here, out of basic concepts and do-it-yourself devices, was a collection of serious toys. We asked if it was fair to call them toys. "Well, toys are really not as innocent as they look," he said. "Toys and games are the preludes to serious ideas. Electricity was a game first, before it became a source of power. There would be no dynamos today if people hadn't once been fascinated by playing with pith balls and glass rods."

"There is a certain relationship between playfulness and art, and there is a relation between playfulness and science, too. When we go from one extreme to another, play or playthings can form a transition or sort of decompression chamber—you need it to change intellectual levels without getting a stomach-ache."

"Much of mathematics has the appeal of magic," Eames said, "and some of it really is—pure magic." He hopes that a traveling show of magic acts, displays and peep shows will follow up the big museum display, reaching an even wider audience.

Experiments in communication have become Eames's major preoccupation. For the Moscow Fair in 1959, at the request of the State Department, he tackled the problem of how to show the character of the United States to Russians in the least time. Seven huge motion-picture screens were set up in a dome that held 5,000 people. The screens, tightly grouped, were fed simultaneously from synchronized projectors. "We had to establish credibility for our description of America," he said. "So we flashed image after image on the screens, each up there for two seconds or so, then gone. At one point, for instance, we were showing thruway interchanges. We put 84 of them on the screens in rapid succession. Now none of those people knew there were 84, but they could see that they were all different and they knew, they really knew, that we have a lot of interchanges in this country. That was the point of the sequence." In sixteen 12-minute shows per day over a six-week period, about 2½ million people saw that display called "Glimpses of the U.S." It was one of the most popular events in the Fair.

This is the essence of Eames. He uses his artistry, his ability to enjoy the complexities of modern knowledge, and his skill at persuading others to enjoy them, to touch the imagination of millions.
The newest plant which brings new life to the town of Amiens is the Goodyear Tire & Rubber Company's, the latest in modern, automated efficiency, built at a cost of $7,000,000. The French town of Amiens is a striking example of what the Common Market is doing for the six-nation European community. Once a depressed area, victim of two ruinous wars, Amiens has made a remarkable comeback.

The Common Market... New Industry Brings New Jobs

by Charles E. Rotkin

Inside the Goodyear plant: The Common Market boom and its influx of industry have provided about 1,500 new industrial jobs.
AMIENS IS AN INDUSTRIAL TOWN about 80 miles north of Paris. Years back, its claim to fame rested on an elegant 13th century cathedral, its paté de canard, filets de sole Godbert and lovely velours textiles. More recently, it learned the bitterness of two wars, when it was a battleground time and again. One third of the town was completely destroyed during World War II. By the late 1950's, Amiens was rapidly becoming a depressed area of France.

But today, a new wind is sweeping the town, and what is happening here is only a microcosm of what is happening all over Europe. Amiens, like many other European cities, has become an active participant in the Marché Commun, or European Common Market.

The formation of this six-nation European Economic Community (or Euromarket, as it is known abroad) is a much needed program that has long been the dream of statesmen, economists and businessmen, many of whom hope that the Community will become a political as well as an economic unity. As far back as the late 1920's, Aristide Briand, 11-time Premier of France, was calling for a United States of Europe, and when he died in 1932, although it still had not been realized, more and more people were becoming aware of the folly of protectionist tariffs that theoretically protected native industries but in effect did more harm than good by creating artificially high prices and stifling international trade.

In spite of the obvious necessity for drastic cooperative action, it was a hard thing to sell. But when post-war economic factors began driving prices out of reach of many people, the advocates of cooperation at last had some forceful arguments. Why not, they said, eliminate artificial costs between neighboring countries, expand trade and increase gross product capacity? Up to then, little incentive was at hand for the foreign manufacturer who was interested in the export market. An American manufacturer, for example, knowing he would have to pay duties to each country he shipped to, preferred therefore to expand his production in Peoria or Akron and ship directly, without having too large a capital investment abroad. But with a Common Market, which is duty free between participating countries, a plant abroad makes sense in terms of closeness to market and distribution. Moreover, with an average wage scale that is considerably lower than the United States, the export market to underdeveloped areas such as Africa and Asia becomes not only attractive but realistic. American manufacturers with whom I spoke stressed repeatedly that their participation was not aimed at re-export back to the United States.

Four years ago, the Common Market was officially activated, and France, West Germany, the Netherlands, Belgium, Italy and Luxembourg began their exciting march toward self-sufficiency. Other nations were invited to participate, but traditional ideas were too strong, and they stayed out. Yet the enormous leap in trade frightened enough of the outsiders to form their own trade bloc, now called the Outer Seven (Britain, Norway, Sweden, Denmark, Portugal, Switzerland and Austria).

In spite of the fact that the six-nation group is now doing over 24 percent of the world trade, much opposition within each country is still prevalent, primarily among the urban middle class who, because of the decentralization programs...
New housing. Along with better jobs has come a demand for better housing. These buildings are part of 4,000 new units now completed; 10,000 more are planned or already under construction.

New building on a main street of the town, another indication of its prosperity, is sharply contrasted with an older structure, right, and the cathedral spire.

In locating new factories, have not actually seen the spectacular growth taking place in their own countries. So far, too, it's quite hard for them to realize that within their six-nation market lies a population (175 million) almost equal to that of the United States. In fact, this lack of knowledge of the program among the people of Europe was curiously revealed in an incident that took place when I started work on this story.

I had hired a French researcher who was a trained newspaper woman to talk with the shopkeepers in Amiens and gather statistics and other information for this article. At first, she was reluctant to accept the assignment.

"I don't really believe in the Common Market," she told me, "and after having spent the war years in the Paris underground, including a jail term that nearly became a death sentence, I cannot see free trade with the Germans and Italians to the detriment of our own industries."

I persuaded her to take the assignment, however, and was quite pleased when at its completion she said to me, "Well, I am amazed. I, as a middle class intellectual, had no idea of what has been going on up here. If this is true in other parts of France, I have changed my opinion and would like your permission to use some of the material we have gathered to do some articles for my own paper in Paris."

She, in her typical way, really knew very little about the Common Market, had heard of it only vaguely, including the gripes, and was prepared to resist it strongly as an incursion of French liberty. All she really knew of Amiens was that it had a great cathedral and was in the "industrial north." Yet she was no different from many New Yorkers who think of South Bend, Indiana, in terms of Notre Dame and its football team rather than as an important industrial city in America.

What does the Common Market program call for? First of all, it is more than just a tariff eradication program. It calls for group efforts over an 8-to-9-year period in many other areas. In the first phase, now completed, France and Italy, traditionally strongly protectionist, have already begun to lower duties on many commodities. Germany and Benelux, have raised theirs very slightly on some items to reach the level for the single external tariff. The plan calls for equalization of wage scales throughout the area, particularly in the case of men and women performing similar tasks. There is still a widespread difference in average hourly manufacturing wage rates among the participating countries. The plan also calls for complete elimination of discriminatory transportation rates, common agricultural policies and other trade practices necessary to economic harmony.

But let us go back to Amiens and see what is happening there, which has meaning for the Common Market idea.

A new industrial zone was created just north of the city, where ample power, rail and water service was available. Five new plants are the core of the new zone. First of major size was British-owned Dunlop Tire & Rubber Corporation, which built a large tire plant there. Following close behind was a French manufacturer of auto parts. Newest and most recently completed is Goodyear Tire & Rubber Company's $7,000,000 tire plant, which is the last word in modern automated efficiency. Other plants under construction and
planned are one for fabricating plastics, and Carbone-
Lorraine, which will build a carbon black plant. (Carbon
black is an important ingredient in tire manufacturing.)
These new plants will provide about 1,500 new industrial
jobs.

With an average family size in France of about five, a
city such as Amiens would normally have about 15,000
industrial jobs, with remaining employment in service trades.
Thus, 1,500 new industrial jobs become about 10 percent
of the industrial working force.

Along with the new jobs has come a demand for new hous-
ing. Many of the people in Amiens are still in temporary
wartime houses, and their needs, plus the normal growth in
population, have lifted the housing demand enormously. Over
4,000 new units have already been completed and a total of
10,000 more are under construction or planned. And the
increase in industrial payrolls has brought the demand for
house furnishings, appliances, automobiles and service trade.

Credit buying has helped this growth enormously, too.
The long familiar Pas de Crédit! (no credit) signs are begin-
ning to disappear from the shops in favor of time payment
plans. The shopkeepers are more confident of the salaried
workers in the new plants and are wooing them assiduously,
as compared to their attitude towards the workers of the
more erratic and unstable textile, light manufacturing and
sugar beet industries nearby. Most shopkeepers interviewed
stated with pride that their sales totals were being exceeded
each year, and only a few small shops which followed tra-
ditional patterns of business in France had yet to feel the
impetus of the new market.

While this growth has been most evident among salaried
workers of the new industries, it has not been restricted to
them solely. The older industries, in their need to keep their
workers, have been forced to improve conditions, salaries
and fringe benefits, and thus the chain reaction is being
felt by much of the entire city.

In many ways, the growth of the Common Market pattern
in Amiens has had curious effects. Goodyear, in establishing
its plant, brought in bilingual instructors for each department,
to train young workers in the operation of the highly
complex tire-making machinery; and since communications
are a vital part of such a program, much effort was expended
by the American technical personnel in learning to speak
French. This was reciprocated in a heartwarming way by the
French workers, who doubled their efforts to learn English.

A personnel director for another large company later told
me of one experience he had during the training period for
workers in his plant. Where the supervisors took the trouble
to learn French the labor-management relations were excel-
Sent and the production quotas were being met without
difficulty. In one department, where there was a serious
drop in quota fulfillment, the trouble was traced directly to
the fact that the supervisor refused to learn French, and the
French workers showed their resentment in obvious ways.

The exchange of ideas reaches all levels. One manufac-
turer in Paris told me of his skepticism of the Common
Market program, particularly in the area of established plants
participating in the new developments. He felt that factories
being built by foreign firms were going to be equipped by the
home companies from abroad rather than by local firms. He
was therefore quite gratified when he received a large order
for machinery from one of the Common Market plants and
then subsequent orders from countries not remotely con-
ected with the Common Market, countries such as the
Soviet Union.

Goodyear, for instance, has made it a point to equip its
Amiens plant as much as possible from the French sources,
with the result that over 90 percent of all the equipment in
the plant is French-built. All personnel, with the exception
of a handful of training people and a few supervisors, are
French, and they, too, are training their replacements among
the French people.

What sort of American companies are investing in the
Common Market? Even a partial study shows that the range
is enormous. Last year alone showed an investment of $421
million in the six-nation area. In the two-year period ending
September 1960, 474 foreign operations were built, invested
in or planned by American companies in Europe. Signifi-
cantly, 379 of this total (or 80 percent) were in the Common
Market, with only 61 (or 13 percent) in Great Britain and the
remaining scattered around western Europe. A break-
down of the various types of operations follows:

Chemicals and drugs, 95; finance and services, 11; instru-
ments, 18; metal and metal products, 31; paper, 13; re-
search and engineering, 11; textiles, 5; electrical machinery,
57; food, 17; machinery, 95; office machinery, 20; petro-
leum, 19; rubber, 11; transportation equipment, 32; miscel-
naneous, 37.

Notwithstanding the impressive figures above, does Amer-
ican industry foresee a real future for itself in the Common
Market? A partial look at the roster of firms gives the im-
mediate answer.

U.S. Firms and the Common Market

American Home Products Corporation has invested 208
million lire (about $330,000) in a pharmaceutical operation
in Milan. In Italy, Godfrey Cabot of Boston will build a
carbon black plant with a capacity of 15,000 tons annually.
Dow Chemical Company will work together with the Dutch
state-owned coal mines to build a phenol plant near Rotter-
dam. Reichhold Chemicals, Inc., long established in Europe,
is expanding and will build a basic chemical plant near Niort,
in France. Collins Radio Company, together with a French
affiliate, will manufacture and sell radio and electronic com-
munications equipment. Parke, Davis & Company has started
construction of a pharmaceutical plant in Belgium, American
Machine & Foundry Company (AMF) is building bowling
alley equipment in Switzerland and Germany. H. K. Porter
Company, Inc., has acquired the assets of a French railway
car builder and will construct cars and components. And
Willys Motors, Inc., will build its jeeps in Sicily.

Meanwhile, back in Amiens. Parking lots for employees' automo-
hiles, long a familiar sight in America, are much in
evidence around the new plants, and heretofore bicycling
workers are beginning to appear in great numbers in their
small-boxed Citroëns and pint-sized Renaults, while their
car-owner colleagues are graduating to the larger Peugeots,
Simcas and an ever-increasing number of imports from the
neighboring countries.

A P R I L  1 9 6 1
Joe Brown and his brain children. In the Princeton gym, the sculptor—and one-time pro boxer—surveys a small world of his own making, a special world of athletic action and fine art.
Joe Brown, a professor at Princeton University, leads a double life — openly and successfully.
A one-time professional boxer, he is also a gifted sculptor and now teaches college students the fine points of sculpture and self-defense.

Joe Brown is a good mixer. More than that, he's an expert — at mixing athletics and art in a rare blend of boxing and sculpture. Back in the early '30's, he was a light heavyweight boxer. Today, officially, he is Joseph Brown, associate professor of sculpture at Princeton University, where he teaches undergraduates the sculptor's art and the art of self-defense as well. To the faculty, and to many of his students, he's known as Joe.

He seems to prefer it that way. Joe Brown is easy-going, energetic, outspoken, an extrovert who pulls no punches. He stands about 5 feet 10, moves with the ease and vigor of an athlete, wears glasses and Ivy League suits. His dark crew cut is slightly flecked with gray. He looks to be in his mid-40's; he's 52. And his manner is anything but professorial.

Over lunch in a student cafeteria, he began to tell us the story of his double life.

First, the basic statistics: He was born in Philadelphia, went to Temple on a football scholarship, majored in physical education with a minor in psychology. He graduated with a bachelor's degree in 1931, during the dismal days of the Depression, but didn't get to Princeton (to teach boxing) until 1937.

When we asked if he really had been a pro boxer he looked at us in offended amazement.

"Sure, sure. I used to go to the gym three times a week and spar with the pros. My brother, Harry 'Kid' Brown, was featherweight champion, later a welterweight when he put on more weight. Harry was my hero.

"Anyway, as I started to say, I used to work out in the gym three times a week. One day, I asked a promoter if he could get me a fight. I was in the ring the next night . . . won by an easy
This one is a life study.

as he charges the line.

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Jesse Owens. Sculptor Brown does many studies from memory. This one is a life study.

Manpower is personified in a roughly textured football player as he charges the line.

knockout and got $75. This was the most money I'd ever seen. Next fight I got $100, and the next $125. . . . But the morning after one fight, at breakfast, I was reading in the paper that the other guy had never laid a glove on me. Well, my tongue was so swollen (I probably bit it) and my jaw so sore that I couldn't even eat soft-boiled eggs. I was beginning to see the drawbacks.

“‘For another thing, it's a pretty weird feeling in the ring, just you and another guy and the referee, all the lights out except the ones on you. And I didn't like having to work out at the gym every day, and fighting whether I felt like it or not. Well, that settled it, finished my ring career. It lasted about three months.’

Getting around to Joe Brown's sculpture, he told us that he'd been interested in anatomy in college, then discovered he could make a dollar an hour posing for classes at an art institute.

“When the students finished a lesson,” he recalled, “I used to look over what they had done. I thought I could do better and started on my own.

“But it wasn't hard being a sculptor in those Depression days. There were practically no jobs to be had, and there wasn't any question of living on a shoestring in a garret. Art, or no art, you lived on a shoestring.”

Joe Brown's strongest influence, we discovered, came from R. Tait McKenzie, a noted Canadian-born sculptor, who was also a football coach and a physician.

“I studied with McKenzie about seven years. He didn't approve of action studies. It was contrary to the Greek ideal of 'before or after the moment.' The Greeks thought action studies were vulgar, so they would show a discus thrower just before the throw, or other athletes just after an action was completed. But I like action.”

Lunch finished, we went upstairs to Professor Brown's studio-classroom. In the middle of the floor, dominating the room, was a bigger-than-life-size boxer, down but not out—a massive, sprawling figure of sculptured brawn. Ranged around the room were action studies, mostly small-scale, of every kind of athlete: boxer, wrestler, swimmer, runner, baseball and football player, oarsman, fencer. All had been caught—by the sculptor's hand—at a moment of dynamic action.

We asked about his students. Did the fact that he taught both boxing and sculpture encourage students of one to try their hand at the other?

“Yes, quite a few in the boxing class will come into the studio to look around, then decide to take a crack at the clay. The same thing happens with the others when they look in on a boxing class.”

As we browsed around the studio, looking at and admiring his extensive collection, we came across two small models which were oddly out of place among the athletes. These were designs for another field where Joe Brown is finding success: playground equipment. One of the models resembled a boxing ring, except that it had several more than the usual number of ropes. His theory: Children should start learning about the give and take of life as soon as they are able to start playing. (He is married—to artist Gwyneth King Brown—but they have no children.)

“When two or more kids are jumping on the ropes here,” he explained, “each finds that his movements are conditioned by the kid jumping on the other side of the ring. They're learning that what they do affects others, and what others do affects them.”

Designer Brown's playground equipment was described in a national magazine article a few years ago. Now, a few businessmen have formed a company, and the equipment will soon be in production. We asked if this new venture would cut into his activities at Princeton.

“No. I'll be president but only in an advisory capacity. I don't like ulcers, and that's what I'd probably get if I decided to be a tycoon. I'd rather leave the business problems to the experts.”

Joe Brown's latest and current venture is a round-the-world trip for the U.S. State Department. He'll be gone about seven months, exhibiting his work, sculpting the leading athletes of the countries he visits, and teaching boxing—specifically to the Indonesian and Burmese boxing teams. His trip will take him to Tokyo, Taipei, Jakarta, Bangkok, Rangoon, Rome, then home to Princeton in the fall.
Dear Dick,

That was a fine talk we had in front of the fire last evening. I was greatly complimented that you wanted to kick things around with me the last night of your vacation, before you headed back to college for those critical final weeks of senior year.

I remember the first occasion we talked, just after you had passed your entrance examinations, when you were wondering what courses to take.

Both times, your father was behind our getting together. He is a very perceptive person, more so, perhaps, than you now realize. When he rather hesitantly asked me if you might come and see me, he explained it this way: He said that there were times when a father could be too close to his son, and he thought that the questions you were asking could perhaps be answered more objectively by someone outside the family. I was delighted because it helped me to straighten out my own thinking, too.

Looking back, however, I'm a little frightened by my own temerity, for you followed my advice almost to the letter. I hadn't sensed, that first time, that you were listening so intently, and this quality, which you possess in a high degree, makes me deeply conscious of the further responsibility I took upon myself last evening.

For that reason, I've decided to write you this letter. Many years from now, when you in turn may be having a similar talk with a younger man, it might be useful for you to read this again and see whether I was on the target.

We talked about various careers that might open out to you — law, the ministry, the foreign service, business. Knowing you as I do, I felt that you would do well in any one of the four. But when I pressed you as to what was really at the top of your list, you broke down and admitted that business was your first choice. But you had some doubts that needed to be resolved.

Two things in particular bothered you. You wanted to be assured that you would find in industry a continuation of the challenge that college had brought you. And you wanted to be certain that you would never have to compromise the high ethical standards which have been the tradition in your family, and which you have fully adopted in your own life.

It was at that point that I interrupted you, and poured out to you my own personal philosophy about the great opportunities, and the great responsibilities, which come to the businessman in this complex modern world.

It is this which I'd like to try to put on paper for you.

First, a word about the significance of the education you are just completing. You were so right, in my opinion, to make it general and not specific. That is what I urged you to do, and I'm more certain than ever that I was right. Even though you majored in English literature, you touched other subjects, such as the natural sciences and economics. And I'm so glad you took a good course in psychology, for the problems of industry today are far more often human than mechanical.

The man who locks himself into a specialty too early may never be able to escape from it if the circumstances of his life change. Business is above all things unpredictable, and the men at the top must have both depth and breadth in their thinking. Two intellectual qualities are required: first, power of concentration sufficient to master a particular subject; and second, the courage to tackle something for which you have not been trained. Young men are not hired for what they know, but for their proven ability to learn.

Moreover, a general education bears directly upon the ultimate satisfactions of life. Some young men seem to think that the sole purpose of college training is to enable them to make a living. That is important, but the real objective of the four years on campus is to enable them to live a life that is worthy.
I was pleased, but not surprised, when you described offers of employment you have already received from several good companies. Your fine academic record would make that certain under present conditions. Brains are in demand everywhere these days, and the smart corporations and institutions are competing sharply with each other to get the best they can find.

When I was myself a recruiting officer, and visited the colleges, seniors sometimes explained their mediocre grades by saying jauntily that they could have done much better if they hadn’t devoted so much time to extracurricular activities. That argument never impressed me much. I always felt that if a young man didn’t take his education seriously, he might not take his job seriously either.

Between now and June, you’ll be doing a lot of heavy thinking about which of those offers to accept, and I’d like to give you a word of advice based upon my own experience. Don’t take it too seriously. The question isn’t that critical. The plain truth is this: you can’t possibly know now which of those jobs is best for you for the reason that so far you have acquired no knowledge about either business or yourself. Don’t delude yourself into thinking that you can now plan your life all the way through. Be content just to begin. Make it the best start you can, but do it with full understanding that trial and error are necessary in building a career. Someday a force completely outside yourself may give you a shove that you won’t be able to resist, and you may move off happily in a new direction which would seem incredible to you now.

At least that is what happened to me. In my mature years, I was doing nothing I had prepared for, and I’m glad it was so. Had I been able to foresee the future, I might have taken the wrong special training, and built serious limitations into my life.

Let’s assume now that you have graduated, have decided which offer to accept, and have arrived on the job. What must you watch out for?

Well, first of all, you must resign yourself to undergoing with patience a long and trying period of apprenticeship. You won’t be made a vice president right off. In fact, it will be quite a while before you will actually earn your salary.

Much that will go on around you will annoy you. In college you moved at your own pace; now you will move at someone else’s. In college you chose your own companions; now they will be chosen for you. That fellow who will be alongside you may not be your sort at all, but he will have some good points or he wouldn’t be there. Discipline yourself and build on those.

Remember that somewhere above you an able man will be watching you, even though you don’t know it. Just fill your job to overflowing all of the time, and let the future take care of itself. Advancement will not be long delayed once it is merited.

Now for the ethics of the business community.

You asked me some pretty searching questions about there being any danger that you might be called upon from time to time to compromise your principles. I respect you for those inquiries. A man who has a sensitive awareness of moral problems seldom goes wrong.

Please be reassured, however. Certainly never in my experience did a superior ever ask me to pursue a course of action that would have violated my personal code of honor. There are, of course, rascals in all walks of life, since human nature is fallible, but they seldom prosper for long. I’ve never seen it commented upon, but I’m convinced in my own mind that the typical leader in business today is a man of deep religious faith. Responsibility brings him humility, and respect for forces greater than himself.

In fact, if I were permitted only one bit of counsel as you enter the business community, I would say just this: THINK
**Take this step with a high sense of mission.** The challenge is very great indeed.

The world is in crisis. More especially, the system of free enterprise upon which the economic welfare of the United States depends is in crisis. The uncommitted nations, whose vast populations may one day hold the power to alter our destiny, are presently trying to decide whether the Russians are right, or whether we are. Our whole way of life is at stake. And this is a fight which cannot be won unless each man does his part. Hereafter, no business decision may be taken to serve self-interest alone. It must first be examined to determine whether it will serve the national interest. Every Russian is compelled to accept that principle, and we should do so of our own free will.

In fact, the voluntary assumption of obligations for the common good is the basis upon which our form of social organization rests. We speak of America as the land of individual opportunity. So it is, but it is also the land of individual responsibility. Each one of us must measure up all of the time or the whole plan fails.

Apply this concept, for example, to the question of incentives. We of the free enterprise faith believe that when a man puts forth an effort in the production of goods and services through which the whole of our society benefits, he should be compensated pro rata. The more he achieves, the more he should be paid. But when self-discipline fails, when incentive degenerates into avarice so that an individual presses the power which he possesses to the point where others are injured, then our whole social fabric is weakened. When enough selfish people do that, society is invariably compelled to move in by law to prevent the abuse, and we have taken another step toward authoritarianism.

I hope that you will be successful in the worldly sense and make some money. It is right and proper that you should, for the profit motive in business is honorable and essential. But never let money dominate your life. In that direction lies nothing but frustration and unhappiness. The end objective of free enterprise in a democracy is not the production of goods and services as such. It is to make it possible for more people to enter richly into those satisfactions of life which they themselves have chosen as worthy goals.

Above all, be articulate. The business story has not been well told in the past. Work out your own credo as you go along, and tell it to all who will listen. You are off on a great adventure, where new ideas will be as important as new products, and you must turn in a superior performance in every area of responsibility.

My best now, and always!

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*Clarence B. Randall*
by Hans Selye

Every day, each of us is exposed to some kind of stress. No one can avoid it. But here, a distinguished Canadian doctor draws on his medical research to suggest a formula for coping with it.

What is stress? The soldier who sustains wounds in battle, the mother who worries about her soldier son, the gambler who watches the races — and even the horse and jockey he bet on: they are all under stress.

The beggar who suffers from hunger and the glutton who overeats, the shopkeeper with his constant fears of bankruptcy and the millionaire struggling for yet another million: they are also under stress.

The housewife who tries to keep her children out of trouble, the child who scalds himself — and especially the particular cells of the skin over which he spilled the boiling water: they, too, are under stress.

What is this mysterious condition that the most different kinds of people have in common with animals, and even with individual cells, at times when much — much of anything — happens to them?

Stress is essentially the rate of wear and tear in the body, in the medical sense. Anyone who feels that whatever he is doing, or whatever is being done to him, is strenuous and wearing, knows vaguely what we mean by stress. The feelings of just being tired, jittery or ill are subjective sensations of stress. But stress does not necessarily imply a morbid change: normal life also causes some wear and tear in the machinery of the body.

Until several years ago, research on stress was greatly handicapped because we had no way to measure it. Then it was found that stress causes certain changes in the structure and chemical composition of the body which can be accurately appraised.
Some of these changes are merely signs of damage; others show the body's adaptive reactions, its mechanism of defense against stress. All these changes add up to the stress syndrome. It develops in three stages:

1. The alarm reaction.
2. The stage of resistance.
3. The stage of exhaustion.

I took a whole book, The Stress of Life, to explain the complex mechanisms through which the body can reduce the wear and tear of stress. And although we cannot avoid it as long as we live, we can learn a great deal about how to keep its damaging side effects to a minimum. We are just beginning to see, for instance, that many common diseases are largely due to errors in our adaptive response to stress, rather than to direct damage by germs, poisons or other external agents. In this sense, many ailments appear to be essentially diseases of adaptation: certain nervous and emotional disturbances, high blood pressure, gastric and duodenal ulcers, certain types of rheumatic, allergic, cardiovascular and kidney diseases.

For our scientific research in the laboratory we gave an operational definition of stress, that is, one which shows us what to do in order to see stress. It is only by the intensity of its manifestations — loss of weight, adrenal enlargement, increased corticoid concentration in the blood, and so forth — that we can recognize the presence and gauge the intensity of stress. The fact that you cannot see it directly, as such, does not make stress less real. After all, as Christina Rossetti put it:

Who has seen the wind?/ Neither you nor I:/ But when the trees bow down their heads,/ The wind is passing by.

For the present discussion, however, our shorter definition, which merely classifies stress as one aspect of aging, is more satisfactory. When so defined, the close relationship between aging and stress becomes particularly evident. Stress is the sum of all the wear and tear caused by any kind of vital reaction throughout the body at any one time. That is why it can act as a common denominator of all the biologic changes which go on in the body. It is a kind of "speedometer of life."

Now, aging, at least true physiologic aging, is not determined by the time elapsed since birth, but by the total amount of wear and tear to which the body has been exposed. There is, indeed, a great difference between physiologic and chronologic age. One man may be much more senile in body and mind, and much closer to the grave, at 40 than another person at 60. True age depends largely on the rate of wear and tear, on the speed of self-consumption; for life is essentially a process which gradually spends the given amount of adaptation energy that we inherited from our parents. Vitality is like a special kind of bank account which you can use up by withdrawals but cannot increase by deposits. Your only control over this most precious fortune is the rate at which you make your withdrawals. The solution is evidently not to stop withdrawing, for this would be death. Nor is it to withdraw just enough for survival, for this would permit only a vegetative life, worse than death. The intelligent thing to do is to withdraw generously, but never expend wastefully.

Many people believe that, after they have exposed themselves to very stressful activities, a rest can restore them to where they were before. This is false. Experiments on animals have clearly shown that each exposure leaves an indelible scar, in that it uses up reserves of adaptability which cannot be replaced. It is true that immediately after some harrowing experience, rest can restore us almost to the original level of fitness by eliminating acute fatigue. But the emphasis is on the word almost. Since we constantly go through periods of stress and rest during life, just a little deficit of adaptation energy every day adds up. It adds up to what we call aging.

In The Stress of Life I cited many examples showing that a brief period of exposure to stress may result in a lasting asset or liability. This is amenable to scientific study because it can be appraised by measuring the body's resistance. When the whole body is temporarily exposed to stress, the result may be either a lasting increase in general resistance, or damage, shock. Similarly, when part of the body is thus exposed, the result may be either increased local resistance (inflammation), or tissue breakdown (degeneration or even death of cells). In all these instances, it depends largely upon the body's response whether or not exposure results in an asset or a liability. This response is directed by a system of opposing forces (hormones, nerve impulses), which meet the stressor from within.

The final outcome always has a triple root, a three-part causation whose elements are:

1. The stressor.
2. The factors promoting resistance.
3. The factors favoring submission.

This is the stereotyped bodily pattern of the response to stress. And it is curious how closely the mechanism which deals with stress within the body of one man resembles that which meets the stress of social relations between men.

Here, perhaps, is where we can learn the most practical lesson from research on stress: in the area of human relations. In my opinion, psychic stress, due to relations between men, is regulated by a mechanism strikingly similar to the three-part causation described above: there is a clashing of interests, which acts as a stressor from without, and there are balancing impulses for resistance and submission which meet the stressor from within. The final outcome is determined not only (perhaps not even mainly) by the stressor itself; it depends upon all three elements of the situation. The lasting manifestations of interpersonal stress — just as those of stress arising within any one individual — can be an asset or liability, depending upon circumstances.

The principal difference is that, in interpersonal stress, the lasting asset manifests itself as a feeling of gratitude, and the liability as an urge for revenge.

Gratitude: perhaps this is the key. More than any other emotion, it seems to me, gratitude accounts for stress, or lack of stress, in human relations. That is, the feeling of gratitude along with its negative counterpart, the need for revenge. (Ingratitude is not the reverse, but merely the absence of gratitude.)
Gratitude, says the author, is one of the most important factors in reducing human stress.

The lasting bodily changes (in structure or chemical composition) which underlie effective adaptation or the collapse of it are aftereffects of stress: they represent tissue memories which affect our future bodily behavior during similar stressful situations. They can be stored. But such bodily changes can only govern our attitude toward subsequent stressors within our body. The aftermaths of stress which most forcefully guide our future interpersonal relations are emotions, such as feelings of gratitude or revenge, which direct social conduct.

I think, in the final analysis, that gratitude and revenge are the most important factors governing our actions in everyday life. Upon them also chiefly depend our peace of mind, our feelings of security or insecurity, of fulfillment or frustration, in short, the extent to which we can make a success of life. But words do not always mean the same thing to everybody and perhaps, before going further, I should explain the sense in which I use the terms gratitude and revenge.

Gratitude is the awakening in another person of the wish that I should prosper, because of what I have done for him. It is perhaps the most characteristically human way of assuring security. It takes away the motive for a clash between selfish and selfless tendencies, because, by inspiring the feeling of gratitude, I have induced another person to share with me my natural wish for my own well-being.

Egotism is the most characteristic, the most ancient and the most essential property of life. Why are we repulsed by it? Why do we try to deny its existence in ourselves if it is natural and unavoidable? I think selfishness, in others as well as in ourselves, disgusts us mainly because it is dangerous. We are afraid of it. We know it will invariably lead to stress situations because egotism is the seed of fight and revenge.

Now, revenge is the awakening in another person of the wish that I should not prosper because of what I have done to him. It is the most important threat to security. But it also has its roots in a natural defense reaction. It is a savage distortion of the natural wish to teach others not to hurt us. When we punish a child for doing something bad, our action comes very close to revenge, even if it is guided by parental love. Punishment is an object lesson which teaches proper future conduct by retaliation. Unfortunately, in practice, it is very difficult to draw the line between teaching by punishment for a constructive purpose, and senseless, purely vindictive retaliation as an aim in itself, a morbid satisfaction of the urge for self-expression.

This brings us to the general problem of working for a reward. Both gratitude and revenge are feelings concerned with reward. They are themselves, in a sense, remunerations: the former for good, the latter for bad actions. But the important point is that both of these types of reward have common, fundamental qualities which might fit them to act as ultimate aims.

We need not give much thought to revenge; it is nothing but a grotesque malformation of our urge to teach, a kind of "disease of the teaching instinct." It has no virtue whatever, and can only hurt both the giver and receiver of its fruits. The seeds of any fruit can only reproduce the tree they come from. Revenge generates more revenge, gratitude tends to incite still more gratitude.

To me, the most striking thing about inspiring gratitude is that it possesses — more than any other value — all those characteristics which we seek in some long-range aim based on the laws of nature:

1. It can act as a common denominator for the most diverse ways of self-expression; each person can strive to inspire gratitude in others, according to his own talents, for instance, through charity, art or science.
2. The effects of gratitude are lasting; they can be accumulated.
3. Neither wealth, nor force, nor any other instrument of power can ever be more reliable in assuring our security and peace of mind than the knowledge of having inspired gratitude in a great many people. This surely is a worthy long-range aim for man. But is it really an ultimate aim?
Man's ultimate aim, as I see it, is to express himself as fully as possible according to his own lights. Whether he seeks this by establishing harmony and communion with his Maker or with nature, he can do so only by finding that balance between long- and short-range aims which best fits his own individuality.

But the goal is not to avoid stress. Studies have shown that complete rest is not good, either for the body as a whole, or even for any organ within the body. Stress, applied in moderation, is necessary for life. Besides, enforced inactivity may be very harmful and cause more stress than normal activity. I have always been against the advice of doctors who would send a high-strung, extremely active business executive to a long, enforced exile in some health resort, with the view of relieving him from stress by absolute inactivity. Naturally ambitious and active men often become much more tense when they feel frustrated by not being allowed to pursue their usual activities.

Let me present a little motto which I developed while analyzing stress in my experimental animals, in my colleagues, my friends and myself. It may sound trivial, but it is based on solid biological laws and, at least in my case, it works:

Fight always for the highest attainable aim,

But never put up resistance in vain.

Everyone should fight for whatever seems really worth while to him. On the other hand, he should aim only for things attainable to him, for otherwise he will merely become frustrated. Finally, resistance should be put up whenever there is reasonable expectation of its succeeding, but never if we know it would be in vain.

It is not easy to live by this motto; it takes much practice and almost constant self-analysis. Any time during the day, in discussions, at work and at play, when I begin to feel keyed up, I consciously stop to analyze the situation. I ask myself: “Is this really the best thing I could do now, and is it worth the trouble of putting up resistance against counterarguments, boredom or fatigue?” If the answer is No, I just stop; or whenever this cannot be done gracefully I simply “float” and let things go on as they will, with a minimum of active participation (e.g., during most committee meetings, solemn academic ceremonies and unavoidable interviews with crackpots).

Probably few people would be inclined to contest the soundness of this motto. The trick is to follow it. But this is where you come in.

One of the main points of this whole discussion is that there is no ready-made success formula which would suit everybody. We are all different. The only thing we have in common is our obedience to certain fundamental biological laws which govern all men. I think the best the professional investigator of stress can do is to explain the mechanism of stress as far as he can understand it; then to outline the way he thinks this knowledge could be applied to problems of daily life; and finally, as a kind of laboratory demonstration, to describe the way he himself can apply it to his own problems.

One case — my own — does not prove much. But, against my laboratory background, one actual experiment proves a great deal more than volumes of pure speculation. In such an experiment the indices of success are purely subjective; therefore, I could not repeat the test on others and still vouch for the veracity of my findings. All I can say is that the philosophy of stress has helped me enormously. I rather think it might help you, too.
They Dug a Trench Under the Mighty Mississippi

Pictures by Orlando

These men were faced with a challenging, hazardous job: laying a new gas pipeline under a mighty river. This is how they won their battle with river currents and Mississippi mud.

Crossing a river has its problems. Getting under a river is a big problem, particularly when the stream happens to be the mighty Mississippi.

This was a problem faced — and solved — by men of the Columbia Gulf Transmission Company. They had solved the problem once, with quadruple pipelines embedded in the river bottom. But the lines which cross the river near Mayersville, Mississippi, taking natural gas to customers of the Columbia Gas System in the northeast, were vulnerable to the dangers of overexposure. Because of shifting currents, the covering layer of sediment was being washed away and the river bank was being eroded, threatening to expose the lines to the river’s violence.

The problem was solved again — at a cost of $3,500,000 — by a task force of river experts, engineers, scientists and skin divers. First, they dredged a new channel, a trench 90 feet wide and 40 feet deep, for the piping. They also dug 900 feet into the

The big pipe. Walkie-talkie men keep a watchful eye on operations as more pipeline sections are added.
Paths of light streak the placid river as operations continue into the night in a race against the capricious moods of the Mississippi.

Lowering-in operations were aided by a fleet of barges, spaced 120 feet apart, which prevented any unnecessary stress on the pipeline.

Dredging expert at the controls: he dug a trench 90 feet wide, 40 feet deep, removed 3.5 million cubic yards of Mississippi mud.
riverbank, removing a grand total of 3.5 million cubic yards of river bottom, silt and sediment. They did this in summertime, when the Mississippi's currents are least capricious. The dredges, which operate on the principle of a vacuum cleaner, pumped 60,000 cubic yards daily.

The new dual crossing was designed to contain internal operating pressures of 1,000 pounds per square inch. To protect the lines from external corrosion and weight them into place, 24-inch pipe with half-inch thick walls were coated with concrete and used for the river sections; 30-inch pipe was used for the dry-land sections. Forty-foot lengths were joined by more than 450 welds; the pipe is engineered to last indefinitely.

In a little less than four months' time — 119 days after the job began — the new pipeline was in service, out of sight but not out of work under the Mississippi.

Heave ho! Plenty of muscle power was needed along with pipelaying and dredging machinery.

Kingpin. During operations, the dredge was kept on course by pin marker which indicated depth of trench.

A straw-hatted inspector takes deadweight pressure reading to test the big pipeline's land and river sections.
What It Takes to Be Your Own Boss

by Herbert F. Stewart

If you've ever considered going into business on your own, here are three stories which can help you decide whether or not you have what it takes to succeed.

HAT, EXACTLY, is the role of the entrepreneur in this age of economic explosion? Does he simply ride it like the flotsam on the crest of a wave? Does he live off it like a parasite? Or does he light the fuse that sets it off? And what does it take to be an entrepreneur in this kind of world?

Whenever I think about these questions, my mind inevitably turns to three Horatio Alger figures I know who would be classified as entrepreneurs in anyone's book. Let me first describe their careers, then make some general comments on what I think it took for them to get where they are. With these three to look at and study, we will be better equipped to ponder the questions asked above.

The first man is Joseph H. Davis, Jr. Joe was born in Brooklyn in 1920. After a hitch in the Navy, he graduated in 1947 from the Harvard Business School.

The first job he had was with a local instrument company, where he was assistant to the president. The company had new products to be developed, and Joe was a natural. His salary was $4,500. He worked for eight months and quit. Reason: He could not get along with the president who, Joe said, was backward, lacked vision, etc.

For his second job Joe went to another local instrument company as sales engineer, again for product development. Joe did not sleep very well that night, but he had an idea. Then he went to MIT, convinced a man that he could do it myself, and the way to start a business is to get an order. So he went to MIT, convinced a man that he could make a certain item, and got two contracts at $6,000 apiece. In his basement he did all the work, using a $200 piece of equipment bought specifically for the job. At the end of the first year, Joe and Bernie, his partner, had sales of about $80,000 and gross profits of about $40,000.

At this point Joe said, "No one is going to give me any money. There is only one way to start a business and that is to do it myself, and the way to start a business is to get an order." So he went to MIT, convinced a man that he could make a certain item, and got two contracts at $6,000 apiece. In his basement he did all the work, using a $200 piece of equipment bought specifically for the job. At the end of the first year, Joe and Bernie, his partner, had sales of about $80,000 and gross profits of about $40,000.

The next day, he convinced his financial backers to put up $250,000 in escrow, subject to receiving the $3,000,000 contract. Last year, the company had about $9,000,000 in sales. The company is now worth over $10 million.

My second character is Peter J. Kanavos. Pete's father came to this country from Greece; he was a barber and died when Pete was 13. Pete had four younger brothers and sisters to support while still going to high school. During the war, Pete worked at the Fore River shipyard, saved enough money to go to Harvard, and graduated in 1946 with a B.A. From there he went to the Harvard Business School, graduating in June 1947 with distinction.

While he was there, he operated a real-estate agency in Copley Square, also had a full-time job as night watchman. Upon graduation, Pete went to New York and looked for a job. Things did not seem promising, so he went back to Boston and bought a bar and grill in Brookline Village for $46,000. Since Pete had no money, he borrowed what he needed from a barber in Harvard Square, his high school principal and teachers, his old newspaper-route boss, the Harvard Business School faculty and others. The bank refused him a mortgage, but he borrowed from the bank president personally. Within 18 months he had refinanced his enterprise with a first mortgage for $20,000 at the bank and had paid off all his other debts.
Next Pete bought a liquor store for $25,000, taking a $15,000 mortgage and getting together $10,000 from seven people. He bought a second store that was going bankrupt, took a first mortgage of $15,000, moved it around the corner, added a delivery service. Total sales went from $800 to $8,000 a week in 12 months.

In real estate, Pete bought a house on Marlborough Street for $40,000; using a first mortgage of $25,000, a second mortgage of $10,000, and third mortgage of $5,000, he remodeled and sold it for $70,000 in 14 months. At this time, he also bought a lot for $2,500 at a public auction and sold it to a gasoline company for $28,000 after obtaining changes in zoning to permit construction of a gas station. Then came a land redevelopment project, the Dedham Shopping Plaza, which is very close to the intersection of Routes 1 and 128 outside of Boston.

Pete has opened or is in the process of opening shopping centers in Marlborough, Massachusetts; Scarborough, Maine; Orlando, Florida, and Norfolk, Portsmouth, Richmond and Roanoke, Virginia. He has developed industrial parks at Marlborough, Dedham, Stoughton and Avon, Massachusetts. He owns the Hotel Raleigh and the Mark Monroe in Richmond, Virginia. He also has an $80 million urban redevelopment under zoning. Pete's estimated net worth is over $5,000,000.

My third "exhibit" is Arnold Ryden. Arnold was born in Clay Center, Kansas, in 1920, but when he was two years old the family moved to Minneapolis. He went to the University of Minnesota, concentrating initially on mathematics and engineering but later shifting to sociology. At this stage he intended to become a social worker. He decided to go to the Harvard Business School and graduated in 1943.

During the war, Arnold was in the Army Quartermaster Corps, serving as a financial analyst and assistant negotiator in contract renegotiation. After his discharge, he took a job with a bank at $300 a month. During his five years at the bank, Arnold supplemented his income by teaching accounting each morning from eight to nine o'clock at the University of Minnesota's business school. He also taught accounting and money and banking in the university's extension division.

In March 1951, Arnold left the bank to become assistant treasurer of a Minneapolis engineering firm. This was his first exposure to technological businesses, and he saw that there was good opportunity in some phases of fast-moving technology, such as electronics, with competent people.

Some months after he went to work for this firm, Arnold discovered that the president was negotiating to sell out to a larger company. Since Ryden did not want to work for a "little offshoot of a big corporation," he began to look for another job.

Through the president of his old bank, Arnold was hired as assistant to the executive vice president of a paint company. He remained there for nine months at a salary of $7,500, but he was given no responsibility or real duties, and he quit.

After two more unsatisfactory jobs, Ryden and a group of associates formed an electronics company in July 1957. To finance it, he and his attorney put up $25,000. He then sold publicly 600,000 shares of stock in the corporation at $1.00 a share. He then sold publicly 600,000 shares of stock in the corporation at $1.00 a share. Subsequently, he helped it acquire a subcontracting company, with annual sales of almost $2,000,000, doing a variety of electrical and mechanical work. In 1960, its third year of operation, consolidated sales of this company were running at the rate of $12 million annually. Its stock was selling over the counter at $40 a share.

Arnold resigned as an officer of the company in October 1958, though he continued on as a director, and formed another corporation. The initial capital of $250,000 was supplied by him and a few business associates. The following May, 500,000 shares of common stock were offered to the public at $3.75 a share. "We tried to get an underwriter for this issue but we couldn't, so we sold it ourselves as issuer and had several people acting as selling agents," he explained later.

Four months later, in February 1959, Arnold and a small group of associates bought a 98 percent interest in a firm that made hearing aids for just over $1,000,000. Arnold
Build your own pyramid. For the individual who wants to go into business for himself — there's still room alongside the old, established firms.

became president, and annual sales rose from $4,500,000 to $20 million.

What lies behind these success stories? What techniques did these three men use.

First of all, they all wanted to own and operate their own companies rather than work for someone else. To achieve this goal, they were willing to work hard, to hammer a career out of solid rock with their own muscles and sweat. Security as such had no appeal for them, and large, well-oiled organizations offered them no challenge. This is not to say that there are no challenges there, of course; it is just that the opportunities did not tickle their particular fancies.

Second, they were not afraid to borrow, nor were they hesitant about going to friends to ask for money. As one of them says, "You really have to develop a borrower's personality; ever since I was a kid, I have had one . . ."

They each had a talent for picking industries that were on the way up, capitalizing on technological advancements, population growth, and the expansion of our urban areas. Together with choosing the right industries, they selected the right associates.

"Everything I have done in the past three or four years," explained one of the trio, "essentially revolves around taking outstandingly capable technical people and combining them with money, and as a result creating something of value."

But simply associating yourself with these talented people is not enough; you have to try to keep them with you so they will not spin off and form a company of their own. This can be a problem, as one of the three indicates:

"You want the type of fellow who is fed up with the standard organization, is willing to go out and perform and has the freedom to develop ideas on his own. But there is a certain amount of control you have to exercise over him . . ."

Generally speaking, our three friends believe in — and one even insists on — the key people' owning a share of the company in which they work. This stipulation holds for the technical people as well as the management.

Another outstanding characteristic is ingenuity. Listen to one of them talk about his land development arrangement.

"We decided to take an acreage that had been relatively undeveloped and thought we would put up 2,500 homes; so we got a huge tract of land. But we did not want to put money into the project at this point.

"We got hold of four real-estate companies to do the selling and told them we would give them an exclusive. We worked out terms and returns. Then we got a big builder. Next we asked the land redevelopers to round up all the developers they could. They brought in about fifty small builders who build ten to twenty homes a year, and we laid out a master plan for them from selling to building to financing. We got the money they all needed, making an arrangement with the banks that if one of them got into trouble we would come in somehow or other. The banks felt that somebody else would be behind the project, despite the fact that these fellows themselves did not have the experience and net worth behind them. So it was a happy situation for everybody."

The sacrifices these men made to their businesses were prodigious. Here is another pertinent quote:

"There is no question if you're going to go in business, particularly a new venture in which you have a very active part, that practically your whole life is going to be devoted to its success. It requires tremendous energy and sacrifices, a lot of worrying . . ."

Then, the willingness to risk — maybe even a passion for gambling — is stamped all over these men. They recognized early along the way that you do not get far in business today, in large or small companies, without taking chances.

But there is one final factor I want to mention, and maybe it is the key to the puzzle. David McClelland, professor of psychology at Harvard, has been studying achievement motivation for a number of years, and he has made an effort to know and understand businessmen at every level and from Timbuktu to Turkey. He has had this to say:

"Singleness of purpose, to achieve above all else, may turn out to be the distinguishing success feature of the entrepreneur."
Man in the Spotlight

Two billion years ago, as far as we know, the simplest one-celled organism first appeared on earth, starting a fantastic safari through the primeval jungles of biological creation. Journey's end is a remarkable multi-celled organism: man himself.

Today, anyone can make this grand tour, in a manner of speaking, at the American Museum of Natural History's new Hall of the Biology of Man. Beginning with a one-celled creature, it traces, on a ceramic tile mural, the sometimes tenuous trail of life. A great divide in this epic journey is the moment, perhaps a million years ago, when the first man-like creature emerges. From here on, life evolves and finally grows into a unique being with a brain; early man, in his struggle for survival, has developed a cranium which helps him fashion crude tools and implements.

To reinforce the mural image, 14 prehistoric heads, models based on fossil records, illustrate the evolutionary growth and changes in cranial development.

As you move into another area of the new Hall, your eye is arrested by a greatly enlarged plastic model of the basic unit of life, the cell, showing its internal structure in magnified detail. To break this basic unit down into special functions, models of specialized cells from different parts of the body — nerve, bone, skin, muscle and connective tissue — show how they are adapted.

Next stage is the complex process of reproduction, involving the male and female reproductive systems, sperm and egg formation and fertilization. A special technique, in which sheets of plastic, special lighting and color are combined, is used to show the ovum leaving the ovary and traveling through the Fallopian tubes to the uterus. A child is conceived and born. As the infant grows, aluminum cut-outs demonstrate the action of pelvic, leg and foot bones, X rays of the hand at various ages help illustrate the growth process.
Man is now full grown. A one-third life-size sculpture, made of hundreds of brass wires, shows his nervous system. A model demonstrates his pulsating heart, valves opening and closing, the pumping action which controls the flow of blood. Successive exhibits analyze how he breathes, his circulatory and digestive systems, how he eliminates waste and how his endocrine gland functions—rounding out a unique, comprehensive portrait of Homo sapiens in his natural habitat.

**Lightning Sleuths**

Two electrical engineers will spend the next several summers on a mountain top near Claysburg, Pennsylvania. Reason: They'll be on the trail of lightning bolts as they use a trailer laboratory of instruments designed to measure the amplitude and record the nature of lightning as it hits a new experimental power line. Results of their studies are expected to tell more about the effects of lightning on extra-high-voltage transmission lines. For without this knowledge, designers would have to provide extra safety margins in future lines—and this adds to both production and utility costs.

The engineers are Steve J. Polaski of the Pennsylvania Electric Company, and Donald J. Heller, of General Electric Company. Their trailer, filled with detection devices, has already gone through a baptism of fire, having been blasted with 40,000 amperes of man-made lightning in a G.E. high-voltage laboratory. Heller is confident that the trailer is lightning proof. He was inside during the tests.

Instruments in the mobile laboratory are connected to a 13-mile, 460,000-volt transmission line. When a thunderstorm approaches, the lab's oscillographs are turned on automatically. These are delicate instruments equipped with cameras to photograph the pattern created on screen by the lightning. And if a storm comes at night, a still camera with telephoto lens records exactly where the lightning has struck. A second, high-speed camera records progressive stages of the lightning stroke.

The mountain region was chosen because of the relatively high "isokeraunic level," meaning that the two engineers can expect 38 to 40 days with electrical storms during the summer months.

**Remote Control Slide Projector**

A new projector is the first to use ultrasonic sound waves to focus and change slides by remote control. Small enough to be carried in your pocket, the projector's remote control device has no wires or batteries and may be used to change slides from any point in a room—even while you're moving around. It can do this job from a distance of more than 40 feet.

The remote control device is easy to operate; only two buttons are involved.

One button, for focusing slides, is hooked up to a miniature transmitter which sends out ultrasonic waves at 36,600 cycles per second; the other button, for changing slides, is connected to another transmitter which sends out ultrasonic waves at 40,000 cycles per second. The transmitters vibrate and create sound waves like a tuning fork; their waves of sound signal the projector, but are too high to be heard by the human ear.

A receiving unit in front of the projector picks up these inaudible sound waves and triggers the focusing and changing mechanisms contained in the projector itself.

The new, ultrasonic projector, developed by Bell & Howell Company, is designed not only for home use, but also for business meetings, for classrooms and lecture halls of schools and colleges. It is transistorized, completely self-contained, is lightweight and portable, and built to withstand shock and high humidity. In addition to its remote control feature, it has a special loading device which makes certain that slides are inserted properly.

**CONTRIBUTORS**

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Wag the world how it will, 
Leaves must be green in spring. 
Herman Melville

He that would make his own liberty secure must guard even his enemy from oppression. 
Thomas Paine

Men are not against you; they are merely for themselves. 
Gene Fowler

Business is like riding a bicycle. Either you keep moving or you fall down. 
John David Wright

I'm very much in favor of unfinished business ... every ... heading in the newspaper represents ... things that have got to stay unfinished ... Us and Russia, that might take a couple of hundred years before it's finished. That's one of the hard things about dying, wondering how the unfinished business will come out. 
Robert Frost

We cannot get grace from gadgets. In the bakelite house of the future, the dishes may not break, but the heart can. Even a man with ten shower baths may find life flat, stale and unprofitable. 
J. B. Priestley

Just as the soaring flight of the fungo fly is the first sight of spring to untold Americans, so the brisk slap of a baseball into a catcher's mitt is the first lovely sound of it. 
John Ward

We haven't all had the good fortune to be ladies; we haven't all been generals, or poets, or statesmen; but when the toast works down to the babies, we stand on common ground. 
Samuel L. Clemens

The man who cannot live in peace with his neighbor, the mischief-maker ... liar ... undutiful son ... negligent parent—by his conduct, which even behind locked doors is never wholly private—keeps peace from the world. He does, in miniature, what ... makes mankind destroy itself. Nothing that man is and does is quite without political significance. 
Karl Jasper

Development of a man's ability in his job, like other kinds of learning, is a continuous process. A man who abandons his efforts to keep up-to-date professionally becomes obsolete just as surely as facilities and equipment do. 
Karl G. Rahdert

Nobody with gumption is what you would call a good loser. But I try to be gracious. 
Terry Brennan

Modern man has tried the suspense of believing nothing, and because suspense is soon unbearable, he has ended by believing almost anything. 
Dr. George Arthur Buttrick

Doing business without advertising is like winking at a girl in the dark. You know what you are doing, but nobody else does. 
Stewart Henderson Britt

The Senior Prom is the point at which we learn how well we are doing thus far. A date means we are popular with at least one other person and, therefore ... potentially lovable. Reassured, we press on. 
Julian Huxley

All Christian worship is a witness of the resurrection of Him who liveth forever and ever. Because He lives, “now abideth faith, hope, charity.” 
Lyman Abbott

One thing this country needs is a clearing house for coat hangers. 
Don Herold

No idea is so antiquated that it was not once modern. No idea is so modern that it will not some day be antiquated ... To seize the flying thought before it escapes us is our only touch with reality. 
Ellen Glasgow

Tenderhooks are the upholstery of the anxious seat. 
Robert Sherwood

Let no man be sorry he has done good, because others have done evil! If a man has acted right, he has done well, though alone; if wrong, the sanction of all mankind will not justify him. 
Henry Fielding

Scientists regard it as a major intellectual virtue, to know what not to think about. 
C. P. Snow

The human capacity for being bored, rather than man's social or natural needs, lies at the root of man's cultural advance. 
Ralph Linton

Only one fellow in ten thousand understands the currency question, and we meet him every day. 
Kin Hubbard

Several readers have written to inform us that Martin Luther was misquoted in our March Thoughts. Rechecking proves that such is indeed the case, though such noteworthies as William Makepeace Thackeray and others have, through the years, attributed the quote to Luther. In any case, THINK meant no harm to Dr. Luther's reputation, and herewith extends its sincere apologies.

THINK
Easter traditions: Above, as they have for nearly 40 years, San Franciscans gather about Mount Davidson's giant cross for Easter sunrise worship.

Back cover: In preparation for another tradition of the season, two young designers pass judgment on their handiwork.