reach for that much consistency. I would certainly have grouped the articles about Warren McCulloch and young Harald Robinson and reminded myself that in a certain sense each is a set of specifications on an item of the most basic resource: the technical manager, the manager with and the hardest to manipulate—smart, imaginative people. I might well have put Bolt's article in the same mental grouping, for Bolt is talking about the value systems which motivate men. Which is to say, in terms of our cover symbol, about tools the manager must use to manipulate a resource.

It is pretty obvious, too, that Frey and Treger are both talking about resource manipulation—about subtle maneuvering of very massive resources or clever steering of very volatile ones. Schon certainly is trying to plot laws of motion which any effective manipulator must work within and understand.

Momentarily, I was tempted to arrange the articles in this issue in a way to underline these connections. But then it occurred to me that I could just as easily have made the articles in any issue of a journal like Innovation, any issue at all, relate to a picture of money.

And that fact in itself is probably the most overwhelming testimonial to the power and the relevance of this month's cover symbol.

The Colossus that is Detroit

To those "mechanics" who would tear down and rebuild the enormously complex machinery of the automobile industry (or any other major system)

- Donald N. Frey - offers essentially the same advice he would give to the man at the corner garage: Tune it up—give it a major overhaul, even—but before you take it apart be sure you understand how it is put together.
One of the recurrent refrains of the late 60's is the one that begins, "Any country that can organize its resources to go to the moon ought to be able to ... (do such-and-such)." Usually, "such-and-such" involves a not-inconsequential change in one of the major systems around which our society is built. Sometimes it is one of the large urban systems—say the city of New York. Other times it is the communications network, or the transportation network, or maybe that giant system known as the federal government. Sometimes it is the automobile industry.

What needs to be recognized is that while such-and-such can probably be accomplished, and may in fact be essential to the continued vitality of the society, it is by no means as easy to do as it appears. Making a significant change in the way the automobile industry goes about its business, say, may be as much an order of magnitude more difficult than making the manned moon program work, and large changes in such complicated social systems as we have in the city of New York may be an order of magnitude more difficult than that.

Take just a very small event in the history of automotive innovations; take the introduction of disc brakes. Before they appeared on American cars people used to say, "Disc brakes have been on European cars for years. Why does it take Detroit so long to put disc brakes on a car? A simple little thing like that?"

What those people failed to realize is that Detroit long ago lost the luxury of having anything be simple. In the automobile industry even the simplest things are matters of great complexity. Once you decide to put disc brakes on the front wheels (just the front wheels, notice—you must start small) of the 1965 Thunderbird, let's say, you've made a decision that affects tens of thousands of cars, tens of thousands of people, and hundreds of manufacturers.

Before the brakes can be put on the car, you have to have the required manufacturing facilities in place, work out the assembly procedures, design tooling jigs, fill the parts pipeline, train mechanics to service the things, prepare, print, and distribute service manuals, prepare dealers and salesmen, set manufacturing and quality standards so you can make the brakes hour after hour, and hundreds of other big and little matters that someone has to attend to.

I was at Ford at the time this introduction of disc brakes was going on and I remember, for example, that we had lengthy discussions about the changes in shipping damage that would be necessary to ship disc brakes from the manufacturing plant to the assembly plant. We spent hundreds of engineering man-hours designing new ways of shipping the things, developing new packing geometries for putting them in a freight car, and setting new damage criteria to be sure they were not being bent, rusted, or whatever.

All of this takes time, perhaps five years between the time we knew we had the technology in hand to the time the brake was introduced on the market. And that completely leaves out all the earlier years spent in patient testing and development under an unbelievably wide variety of conditions of use (or, more properly, misuse and abuse, because that's what the product gets in the hands of the consumer). It also leaves out the years of research into high-temperature materials, heat transfer, friction coefficients, wear tests, and so forth. And in the end, it was the technology of the ventilated rotor disc from, of all places, the railroad car business, that made the whole thing possible, for the unventilated disc used on European cars is unsuitable for heavy American cars.

The point I am making is that when you manufacture a complex product in the volume that we manufacture automobiles, it is very difficult to make a big change in the production or support system, and even a little change—just the front brakes on one model—involves a multitude of not-so-simple changes on every level and division of the industry. This is not to say that Detroit always moves as rapidly as it can, or that it is as innovative as it could be. Far from it. It is simply to say that anyone who goes about to introduce change or innovation into such a large, in-place system as the automobile industry must understand the kind of system it is or his efforts will be in vain.

This whole thing has special meaning for me, however, because it seems to me that the automobile industry must be one of the classic examples of a huge, mature, established industry that cannot change easily, and yet depends upon change to stay alive. There are a number of other systems that have similar characteristics: the power generation and distribution system, the education system, the health-care system, the housing system. They are all ponderous, complex systems that have become an integral part of the economy. How change is accomplished in these systems, with the severe restrictions their size imposes, is, in many quarters, a wholly misunderstood process.

They all have certain qualities in common, these large systems. In the first place, they have a lot of money invested in them, which means you can't tear the system up and replace it with something new very fast. They also involve large numbers of people—both as participants and consumers—and that implies additional sluggishness because people's behavior patterns and predilections don't change very rapidly. And finally, whether it is apparent to the onlooker or not, there is usually a very sophisticated technology present, which means that you will have to have equally sophisticated technology if you want to change it.

Take the railroad business. Take their rolling stock. It's big, heavy, clumsy, a lot of it looks as if it was built in the 1890's (some of it was) and as if it hasn't changed since. But do you realize what a pounding a freight car takes every year it is in service? The railroads beat the hell out of their equipment in service. A freight car is big and heavy for a reason: if it wasn't it wouldn't survive. I'm not arguing that technology can't de-
velop a light, cheaper-to-operate, long-life freight car. I'm only saying that before you assume that modern technology could easily build a better freight car, be sure you understand why it was built that way in the first place.

All of my experience with these enormous, slow-changing systems has been with the automobile industry. It is, nevertheless, a strongly representative member of the family. It is, first of all, very large. If you take the whole thing, you must consider in addition to the automobile manufacturers and dealers, the road system, the corner gas station, all of the independent parts manufacturers and distributors, and hundreds of thousands of small companies whose business is dependent in some direct way upon the automobile. There is a ganglia of interconnected enterprises running through the whole American economy, and it goes far beyond the manufacture of those products that have Ford, Chrysler, GM, or American Motors nameplates on them.

Altogether, the automobile industry comprises about 10% of the American economy; it is said that one in every six people works in the automobile industry or one of its related activities. I added it up one time and discovered that the total investment in automobile transportation in the United States—rolling stock, plus roads, plus corner gas station, etc.—amounts to about 2 GNP's! That represents an almost inconceivable amount of inertia in what is basically a single approach to the transportation problem—individual, four-wheeled vehicles, individually powered and controlled. Whatever you do, it cannot be changed very quickly.

In addition, the automobile industry is unique in at least one respect. It produces a very complex product in very large numbers. The aircraft industry produces a much more complex product, but they make 100 of them and sell them for $10 million apiece. The telephone company makes more telephones but, complex as it is, the telephone is much less complex than a modern automobile. In terms of volume and complexity—or let us say the product of volume times complexity—the automobile industry stands alone. There is no other human enterprise like it; in this respect it is bigger than anything else in the world.

We hear a great deal about the "economies of scale" that work to the benefit of any such high-volume operation. We hear, for example, that the manufacturing cost of an item drops at a predictable rate as the production volume increases, or that the cost of providing a given service fails in proportion to the number of people using it. We seldom hear about the "adversities of scale," the qualities that make a large organization harder to change, more difficult to keep viable and lively. Being big has its advantages, to be sure, but it also has disadvantages. The sword cuts both ways.

Let us suppose we are a group of legislators contemplating a law requiring that all automobiles be powered by gas turbines by 1975 so as to reduce the problem of automotive air pollution.

The first thing that happens is that someone does a little analysis and finds that a turbine is a very expensive thing to make, compared with the piston engine. But somebody else comes along who is a little more sophisticated and says, yes, but we will develop new materials and new production techniques and then the cost will come down because instead of making them by the hundreds we will make them by the millions. Economies of scale. At this point it begins to look almost practical, and that is frequently the point where analysis stops when it is being done by someone outside the automobile industry.

What gets left out in the analysis is that beyond the problems of designing and producing the things are the problems of marketing, servicing, fueling, and maintaining them. In the case of the gas turbine, probably the most important limiting factor is that there isn't the infrastructure in the United States to service a gas turbine at every corner garage. There are no trained people, no technology, no service equipment, no parts suppliers, no distribution for parts, no retail suppliers, no retail outlets for either the mechanic's labor or the parts themselves. You've got to turn the whole system upside down.
Even a small change can set into motion a remarkable interconnected chain of events. One of the changes I worked on in the last few years that I was at the Ford Motor Company was a switch from the traditional bias-ply tires to the new bias-belted tire. Bias-belted tires will be standard on all cars beginning this model year. One might assume that a change of that kind would be pretty easy to make: All we do is to order a different kind of tire from our suppliers and put them on the car.

But there's that enormous system again. The story doesn't start with the bias-belted tire; it starts with the radial tire, which is the next step beyond the bias-belted tire in terms of departure from the traditional bias-ply tire. For many years we had been wanting to offer radial tires on our cars because they have a long wear life and provide good traction in the wet. We had been hesitant to do so, however, because they are expensive and can result in a harsh ride. But with the growth of consumer expectations and the pressure of the safety act we finally decided that we would offer them as an option of several car lines in 1968, as I remember. The reason was that the benefit outweighed the cost: We could recover our cost structure and the consumer got a better break. It was one of those cases where both the consumer and the manufacturer could make out.

We had to consider more than the cost of the tire when making this change, however. Because of the design of the tire, the suspension of the automobile had to be redeveloped, and that set off the chain reaction I have been talking about—engineering, tooling, service, manuals, parts supply, marketing—the whole thing. So it was not a minor change for us. As it turned out, it was not a minor change for the tire companies either.

When we developed the suspension to accept radial tires (and incidentally it still had to be able to accept conventional tires as well) and offered radial tires as an option, we had no real idea of the size of the market. We didn't know whether we would sell 1% radial tires or 10% radial tires. We simply stocked the assembly plants with every radial tire we could get from every manufacturer we could get, despite the fact that they were available in only small quantities at that time.

This initial step showed we were serious about improving tire technology for our customers, and the customer responded by buying more radial tires than we anticipated. But that put the tire companies in a bind because they didn't have the tooling to manufacture large numbers of radial tires and you can't build radial tires on ordinary tire-making equipment. Therefore the tire companies turned around and developed the intermediate tire—the bias-belted tire—which can be built on the existing tire-making machines and can be produced with much less capital investment. It is my belief that they will build up their investment in radial tire-making equipment over the years and eventually the radial tire will replace the bias-belted tire as a volume premium tire.

This is typical of the history of innovation in large systems: A small change here triggers another small change there, which sets off several other changes elsewhere, and pretty soon you've turned the whole system around. It can't be done overnight, and it can't be done without understanding how the system is set up. But it must be done, and despite increasing difficulty, it will be done.

One of the important characteristics of large systems is that innovation on the technical side demands innovation in other facets as well. The engineer's hell is paved with brilliant technical innovations that failed because the company never solved the marketing, distribution, and service problems. They didn't understand the system they were working with. Somebody was hollering down a rain barrel and all they got back was an echo.

People generally think of innovation in terms of technology, science, research, and engineering. When they talk about introducing innovation they are generally talking about technical innovation. It is rare that anybody talks about technical innovation in terms of figuring out a new way to market the stuff. Perhaps it doesn't market under the old rules. Perhaps you can't run it through the old distribution system. You can't put gas turbines in cars next year or the year after that, not because we haven't solved the technical problems (although those are difficult enough) but because we haven't got the system to take care of them. You think you've got service problems with your automobile now; put a gas turbine in every one of them and see what happens for the next decade.

There is just as much risk in introducing novel new ideas in marketing or service areas without first understanding the system you are dealing with. Let's take service innovation. Suppose we decide to set up service centers that are not tied to the retailing of new and used cars. It's a suggestion that has been tried in a few places. Will it work? Is it economically viable? First you must ask if the service business is there only because it is a necessary adjunct to selling cars, and you have to have the two hooked together to support the service business. It may turn out that the two can be separated, but first you must ask that key question.

Service how? By unit replacement with a new one, or by on-the-spot repair of the old one. It may seem more practical to merely require the mechanic to replace a defective black box with a new one—a new carburetor for a faulty one, for example—but it may not be economical. You come up to the question of what do you do with the faulty carburetor. Do you send it back to the manufacturer and, if so, what are the economics of that system? It has turned out in a couple of cases that despite the beautiful theory of unit replacement the economics simply wouldn't work.

Or let's consider franchising. Suppose you decide to separate the automobile tran-
chises from the heavy truck franchise; there's no sense in having the big over-the-road trucks sold at every Ford dealer in the United States. So you decide to specialize the franchise. That's an innovative step taken by a former boss of mine. But it is an enormous one because you have to get all the dealers to agree to give up their heavy-truck franchise. After all, they have legal rights under these franchise contracts and the automobile company can't simply change the agreement unilaterally.

Or let's look at warranties. I noticed in the paper recently that Ford has reduced the warranty period on their automobiles. That's a big step. (Some may believe it is a step backward.) One of the factors in that decision was that the FTC (and the public) has been complaining recently about the inequitable administration of warranties, the deception of the consumer, and so forth. It is interesting to reflect upon the fact that one of the solutions to that problem is to simplify the warranty. That's one solution. I'm sure it is the one the FTC had in mind, but it is one solution.

I'll say it again: Before you introduce an innovation you must understand the system—understand among other things that it is frequently big and complex and slow to move. Then you are in a position to take a small but significant step. Until then you are a neophyte, you are innocent, you are naive, and you will get bloodied up and thrown out.

Change is essential to the system, and yet the bigger the system, the less important change seems to be. The big system seems to have a stability of its own. Moreover, the effect of the small innovative step you are about to take seems as if it will get lost in the big system. The short-term risk looms large by comparison with the amount of difference it seems to make.

The beautiful hidden problem here is that if you don't innovate, if you don't take what you think to be the short-term risk today, you are taking the biggest risk of all, which is the risk of becoming obsolete in the long term. It's an easy mistake to make because the long-term risk of obsolescence is always tomorrow. It isn't in front of you every day and it isn't as well defined as the short-term risk. It's the problem of the risks I know today vs. the risks I don't know... well, I may even be retired by then.

It's an article of faith in the automobile industry that you have to change or you will die. Change includes not only technical changes like changing the brakes from drum to disc, but styling changes, and changes in structure of the organization or the way of doing business. Change is inherent in the automobile business.

The pressure for change comes from all quarters, but by far the most important one is competition. About ½ of the new cars purchased are the same make as the last one the customer owned. Now, that's a high degree of brand loyalty, but it still leaves a very large number of customers who presumably have no preconceptions about the brand of car they want and are possible targets for any of the manufacturers. Every manufacturer wants as many of those uncommitted customers as he can get, and he depends upon innovation to attract them. He attempts to offer a more attractive package with more desirable features with more appealing marketing than his competitor offers.

But his first responsibility is to hang on to the two thirds who purchase his company's car the last time, and there it is not so much a question of what he offers this time as it is a question of what he provided last time. Basically, that's a question of reliability: It didn't leak, squeak, rattle, or fail to start every morning. And the gas and oil consumption was, in some mysterious way, acceptable. Such reliability is also a matter of innovation and, again, it doesn't depend upon a single feature, such as a transistorized ignition system, or even upon a single kind of innovation, such as technical innovation, but upon the whole range and scale of activities that characterizes the automobile industry.

It isn't enough that the car is designed to be reliable, it must be put together properly, it must be prepared for delivery properly and it eventually must be serviced properly and expeditiously. It does no good for a manufacturer to design a trouble-free automobile if his service representatives don't have the proper tools to maintain it, or the proper parts to fix it when it does misbehave. A man's view of reliability depends on a whole spectrum of things: Did he have to call in for an appointment three weeks from now and get up at 7:00 in the morning to get his place in line? Was it fixed right the first time? Was the dealer courteous? Was the car out of service a few hours, or did it take weeks? Holding on to his ½ requires of the manufacturer as much innovation—probably more—as it does to attract that uncommitted ½. But it's a different kind of innovation.
It is typical of large systems, and the automobile industry is as representative of this as any, that the targets do not stand still and that what is good enough today is completely unacceptable tomorrow. With the passage of time, innovation grows more difficult, more expensive to accomplish, more time consuming to introduce, more risky to invest in. This is partly because the system grows inevitably bigger, but it is also because the pressures on the system begin to multiply and begin to push it in unaccustomed directions. What began as a large, rather complicated system responding to a rather simple set of forces becomes an enormous, exceedingly complex system responding to a variety of simple and compound forces.

Consider cost. One of the first things a junior engineer in the automobile industry learns is that his great idea for improving the product is fine and right but, oh, by the way, it shouldn’t cost any more than the last way we did it. In fact, in most cases, the last way we did it is already too expensive and we are already looking for some new way to do it at less cost. Someone who worked it out not too long ago discovered that if you made cars today entirely the way they were made fifteen years ago, but with today’s labor rates, it would come out to something like twice the present cost. In that period of time, we have probably reduced the direct labor cost per car to about half of what it was. That wasn’t done at no cost. There was, first of all, the cost of an enormous engineering effort—simplifying fasteners, reducing a three-piece assembly to one, replacing a machined part with a formed part, thousands of big and little things that add up to a product that costs less to manufacture. It was also at the cost of a very large investment in capital equipment—automatic machinery that allows parts to be made without the direct labor of people.

One of my favorite examples of this is the speed-control device that Ford offers as an option on certain of their automobiles. It is sold in some volume, not much, perhaps tens of thousands. What appeals to me about it is that it is a beautiful little servo, with all the hydraulic, mechanical, and electrical technology of the servos that are used by the dozens in airplanes. If you described it to a group of engineers, just in terms of its performance characteristics, you would talk about it as a closed-loop, closed-center-valve servo system, with such-and-such a response and such-and-such a transfer characteristic. It could easily sound as if it cost hundreds and perhaps thousands of dollars. Surprisingly enough it has a direct manufacturing cost of, as I remember, about $18. The first hand-made one probably cost hundreds of thousands. And then it got down to $1000. And then the process engineers went to work on it and spent thousands and thousands of man-hours. “Do I have to do it this way? Can’t I do it that way?” “Instead of a fancy investment—cast, alloy-steel part, I think I’ll make it on a punch press.” And pretty soon they are making it for $18.

The cost restraint works both ways: on the one hand it discourages the good, but expensive idea and on the other hand, it stimulates innovation aimed at reducing cost. On balance, it is a much greater stimulant than it is an inhibitor.

In recent years there have been new pressures on Detroit, and like the restrictions of cost, these pressures have both an inhibiting and a beneficial effect. These pressures come largely from government, but also from concerned citizen’s groups troubled about such issues as highway safety, or the polluting effects of the internal combustion engine.

On the beneficial side, the new pressures have the effect of establishing a constructive set of tensions between the government and the automobile industry. For the most part, the industry has to be pushed into safety and antipollution reform because their first concern is to sell a product and make a profit, and these modifications generally raise the price without necessarily making the product any more salable. So there is a provocateur role there, and I don’t think there is anything wrong with that.

Consider the safety issue. There is continual disagreement between the automobile manufacturers in Detroit and the administrators of the safety program in Washington. This is to be expected: There are two different points of view and two different sets of equities. From the point of view of the administrator in Washington, the question is how to save lives by changing the design of the car, and from the point of view of the auto manufacturer, the question is what the design will cost and whether he can sell it to his customer. Those are the elements of a constructive set of tensions. Out of these intense encounters comes practical progress.

On the negative side, the pressures from the government increase the business risk connected with the introduction of new safety devices. When you change the braking system from drum to disc, for example, there are bound to be difficulties in the beginning, and if the government requires that cars be publicly recalled under conditions that may unjustifiably discredit the manufacturer or the design, the net effect will be to inhibit manufacturers from trying something new.

Or let’s take the air bags that have been proposed as an alternative to seat belts for restraining passengers in a collision. Ford has been running some preliminary tests on air bags over the last few years, and now the safety administrators have begun to talk about requiring air bags on all cars by 1972. That could be a very serious problem for the automobile industry because the equipment is not yet ready either from the point of view of failure safety reliability, or from the cost/price/value point of view, as measured in the minds of the customers who will have to
pay for it. If Detroit were unable to meet either requirement by the deadline, it could have very serious consequences. And so one of the new risks of introducing a new idea is that somebody will turn around and make it law before you are ready for it. I see that risk getting larger every day.

But there is no question that the principal effect of new pressures is to produce better automobiles, not by the imposition of a set of design rules, but by focusing public attention on a neglected area of design—safety, for example. In that way, the people who should be thinking about better ways to make automobiles—the professional automobile engineers—will begin to think about safety. Safety then becomes a competitive factor in the marketing of automobiles. That's what the safety administrators really have going for them. The result of that set of forces—the competitive forces—will probably be the biggest single factor in the improvement in automobile safety. Given that incentive of self-interest, watch what Detroit does with it!

The constant risk with a large, slow-moving system is that it will not be able to respond quickly enough to large shifts in technology or consumer demands. That is when the system becomes obsolete, and you become the last manufacturer of ice boxes instead of the first manufacturer of electric refrigerators. The shift may come from within the industry, or it may come from outside; it may appear quite slowly and subtly, or it may come on quite suddenly and with obvious implications.

Today, for the automobile industry, there are warnings that the internal-combustion engine is about to be displaced by some other kind of power source, or that the entire concept of individual private automobiles is going to be scrapped in favor of some kind of mass transit system. Such warnings cannot be ignored. Such changes could very well occur, and it is essential that the people in the automobile industry understand the implications and probabilities of such a change—and they largely do, I think.

The company's early warning system for detecting the approach of revolutionary technical change, as well as smaller changes, is the research department. It is the research department that should give management the foresight needed to appraise future developments and future changes in the market. And it is research that keeps the company in touch with a wide range of activities, both within the industry and outside of it. It assures management that they have cast their net widely enough to catch the broadest possible variety of ideas.

It may seem strange to describe research as information gathering rather than as exploration, but it seems to me that this is as important as any contribution it can make to the corporate scheme of things. A new idea, a new way of doing things, is as likely to come from someone else's research organization as it is from your own. It is as true of other industries as it is of the automobile industry. The research done in your own labs is merely a contribution to a vast technical base.

What the company takes out of this base may have nothing to do with the basic research it put in. There is no one-to-one correspondence. The research investment is, as much as anything, an admission ticket to a club of the world's scientists. You don't depend on it for your commercial end to any degree. You depend instead upon the world's technology, to which you have access by being a member of the club.

Basic research also provides a trained group of observers and interpreters of what is happening at the forefront of science. Such people cannot be onlookers of science, they must be participants. Researchers are the best qualified to understand the importance of anything that may happen in their field of technology and to appreciate the significance of it as it relates to your business. And again, it may have nothing to do with what's going on in your laboratories at any point in time.
Another factor that is going to help keep the automobile companies from putting themselves out of business is the new emphasis on what has been widely called systems engineering. It doesn’t matter much what you call it, but what it amounts to is that the automobile companies are beginning to concern themselves with a much wider range of activity than the narrow concerns of building today’s kind of transportation (and at a profit). At about the time I left Ford, the whole organization was being set up according to the systems concept. It was not revolutionary change; the organization had always been structured around the systems, subsystems and sub-subsystems of the automobile. I think the change was more a reflection of the fact that the automobile and its various subsystems are becoming more complex and more technically interrelated, often with things outside the automobile.

Forty years ago internal combustion automobile engines were producing an amount of pollutant that was unnoticeable in the atmosphere. Today, sheer numbers have made pollution an important factor in Los Angeles. Suddenly the automobile manufacturer has to relate to the agricultural economy of the area—he is messing up the truck farmers, not to mention the citizens who get tears in their eyes. What it means is that he must design automobiles for something more than safe transportation at low cost; he’s got to worry about his effect on the ecology. And that, in modern parlance, is a systems problem.

Or consider another example. With the advent of skid control on automobiles (and I understand it will be standard equipment on the Mark III Continental next year) you’ve got a little black box full of electronic logic under the glove compartment to control the skid condition on the rear wheels. With that small step, I could take another step and connect the logic box to an external control that will intercede in the logic and cause the car to stop in response to some kind of roadside signal. Suddenly I have a problem that extends beyond the traditional boundaries of the automobile manufacturer. Suddenly I have a systems problem. Who’s going to provide the roadside signals, and for what purpose? What about compatibility with cars not equipped with the stopping equipment? What about the cost distribution between what you put on the car and what you put on the signal and who is going to pay for what? There are maintenance problems, political problems, legal responsibilities.

Detroit long ago passed the age of innocence; it is a big system and no amount of simplifying or restructuring will change that. The concepts of systems engineering—regardless of what you call them—are an essential element of the modern picture.

For some, this is cause for distress. The big organization seems so much less manageable, so much more likely to get out of control, so much less responsive to the usual management techniques. Contributing to the large organization may seem much less rewarding than working in some organization where dramatic changes can be brought about almost overnight.

Dramatic changes, however, are not the stuff of which technology is generally made. Nothing we did at Ford was revolutionary; nothing as spectacular as the development of the transistor, or atomic energy, or the computer. But those are the exceptions. The bulk of technology is slow, evolutionary plodding.

I like to think that it is just as intellectually challenging—and rewarding—to contribute to this slow metamorphosis of a massive system as it is to play a role in a revolutionary development. To take one of these big, big systems and change it—that is the workaday world for the technologist, and a far more common thing for most of us.
Comment the Editors (CJL/EH):

Frey is a study in contrasts. Read about him and you will discover that he is a PhD metallurgist who taught for a time at the University of Michigan, a man who speaks Russian and French, reads 1300 words per minute, and was once selected "Young Engineer of the Year" by the Detroit Engineering Society. You might reasonably assume that he is a quiet, intellectual sort of fellow who carries a slide rule in his shirt pocket, wears a scruffy weed sport jacket, and forgets his wife's birthday. But as you read further you learn that he is the man responsible for putting Ford back into automobile racing, that he supervised the innovations for which he is celebrated. "What's important," Frey explains, "is that you know what he's doing and he knows you care. That's the key, and you are at it every hour of every day."

A detailed view of the automobile industry, the kind of giant it is and how it got that way, can be found in a number of good business biographies. For two of the most comprehensive and authoritative see, "My Years with General Motors," by Sloan (1956, Doubleday, $7.95) and the three-volume work, "Ford: The Times, the Man, the Company," by Nevins (Scribner, 1963, $10 ea.). For other views of the automobile industry as a big system, see, "Dynamics of the U.S. Automobile Industry," by Edwards (J. of S. C. Press, $6.75) and "The Great Organizers," by Dale (McGraw-Hill, $7.50). An insight into the modern Ford organization and Frey's contribution to it will be found in "There's Another Generation of Whiz Kids at Ford," (Fortune, Jan. 1967). His part in Ford's racing program is documented in "Ford: The Dust and the Glory," by Levine (Macmillan, 1968, $12.50).

One imagines that the advertising man who came up with the slogan, "Ford has a better idea," had just emerged from a conference with Donald N. Frey. Frey, who was for several years General Manager of the Ford Division of the Ford Motor Company, has a passion for new ideas that approaches the fanatic. He has been called "Detroit's sharpest idea man," and his assertion that "there is a better way to do anything" is such a commonplace around his office that it has become a Frey trademark. Among the "better ideas" he promoted while at Ford were the disc brake, the two-way tailgate for station wagons, the built-in tape player, the four-door Thunderbird, and the four-wheel-drive Bronco. But he is probably best known for his contribution to the Mustang, the most successful new car ever introduced.

From general manager of Ford, Frey moved to corporate vice president for Product Development in 1967, from which position his eagerness for better ways of doing things could be felt throughout the entire organization. But Frey is a man who enjoys getting his hands into the machinery of a large system and making something happen, and so it was that late last year, partly for that reason and partly because he wanted to try his hand at something different, he moved to become president of General Cable Corporation in New York.

Donald N. Frey.

programs that resulted in Ford victories at LeMans in 1966 and 1967 and the first Ford win at Indianapolis in 1965, that he enjoys driving fast cars, and that he one time negotiated for the purchase of the Ferrari racing car factory in Italy on behalf of Ford. Suddenly he becomes a dynamic, square-jawed executive, a would-be racing driver who affects cowboy boots under neatly tailored suits.

The man himself is neither of these... and yet he is both. Perhaps the quality that is most evident to a visitor is a kind of relaxed, unfappable confidence, in himself and in those around him. Clearly, he understands that a big job cannot be done alone—that if you are going to move a giant you need to pick good people, give them responsibility, and have confidence in their abilities.

He is a man who loves to prowl the laboratories and assembly shops, chatting with the personnel. He'll stop a man in the hall with, "Say, I heard about that idea of yours, Joe. Tell me about it." And from such small beginnings come the