CHAPTER ONE

Creativity and Constraints

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Most managers and management educators have a list of what they consider the essential properties of good management. I am no exception. My list, however, is unique because all the characteristics, properly enough, begin with C:

Competence
Communicativeness
Concern
Courage
Creativity

The greatest of these is creativity.

Without creativity a manager may do a good job, but he cannot do an outstanding one. At best he can preside over the progressive evolution of the organization he manages; he cannot lead it to a quantum jump—a radical leap forward. Such leaps are required if an organization is to "pull away from the pack" and "stay out in front." Those who lack creativity must either settle for doing well enough or wait for the breaks and hope they will be astute enough to recognize and take advantage of them. *The creative manager makes his own breaks.*

Educators generally attempt only to develop competence, communicativeness, and (sometimes) concern for others in their students. Most of them never try to develop courage or creativity. Their rationalization is that these are innate characteristics and hence can be neither taught nor learned.

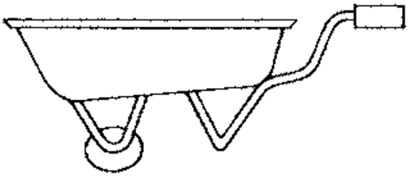


Figure 1.1.

That creativity can be acquired seems to follow from the fact that it tends to get lost in the process of growing up. Adults recognize that young children, particularly preschoolers, are full of it. I recall a dramatic illustration of this point given by an eminent student of creativity, Edward de Bono, in a lecture to an audience consisting of managers and management scientists. He drew a picture on the blackboard of a wheelbarrow with an elliptical wheel (Figure 1.1) and asked the audience why it had been designed that way. There was a good deal of squirming, murmuring, and embarrassed tittering, but no answer. De Bono waited, letting the discomfort grow. He then told his audience that he had recently asked the same question of a group of children and almost immediately one of them had rushed to the board and drawn a squiggly line such as that shown in Figure 1.2. "The wheelbarrow is for a bumpy road," the child had said. The audience blushed and laughed self-consciously.

Most of us take for granted both the creativity of children and its subsequent loss. We do not try to understand, let alone prevent, this loss. Yet the disappearance of creativity is not a mystery; the explanation lies in a query that Jules Henry (1963), an American anthropologist, once made: What would happen, he asked,

> . . . if all through school the young were provoked to question the Ten Commandments, the sanctity of revealed religion, the foundations of patriotism, the profit motive, the two party system, monogomy, the laws of incest, and so on . . . . (p. 288)

The answer to Henry's question is clear: society, its institutions, and the organizations operating within it would be radically transformed by the inquisitive generation thus produced. Herein lies the rub: most of the affluent do not want to transform society or its parts. They would rather sacrifice what future social progress creative minds might bring about than run the risk of losing the products of previous progress that less creative minds are managing to preserve. The principal benefi-

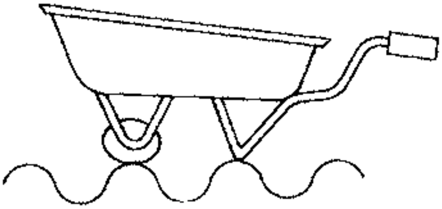


Figure 1.2.

ciaries of contemporary society do not want to risk the loss of the benefits they now enjoy. Therefore, they, and the educational institutions they control, suppress creativity before children acquire the competence that, together with creativity, would enable them to bring about radical social transformations. Most adults fear that the current form and functioning of our society, its institutions, and the organizations within it could not survive the simultaneous onslaught of youthful creativity and competence. Student behavior in the 1960s convinced them of this.

The creativity of children is suppressed at home and at school where, Jules Henry (1963) remarked, "What we see is the pathetic surrender of babies" (p. 291). The eminent British psychiatrist Dr. Ronald Laing (1967) reinforced this observation: "What schools must do is induce children to want to think the way schools want them to think" (p. 71). Schools want them to think the way parents want them to think: conservatively, not creatively.

It is easy to see how schools suppress creativity in children. For example, when one of my daughters was in her early teens she came into my study one night with an extra-credit problem that her mathematics teacher had assigned for homework. On a sheet of paper distributed by the teacher were nine dots that formed a square (see Figure 1.3).

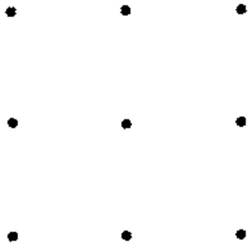


Figure 1.3.

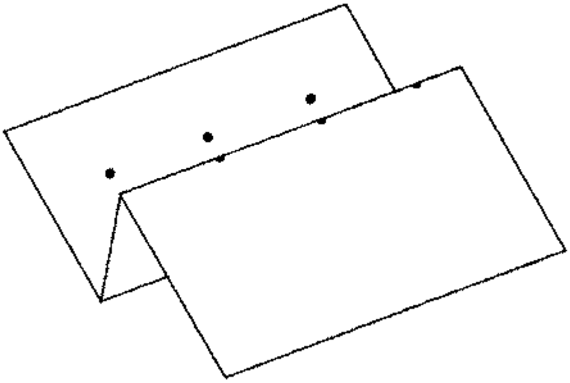


Figure 1.4.

The instructions below the figure said that a pen or pencil was to be placed on one of the dots and then four straight lines were to be drawn without lifting the pen or pencil from the paper so that all nine dots were covered by the lines.

My daughter had tried to solve the problem, with no success. She asked me for help, assuring me she would not claim the solution as her own. I recognized the problem, but I was unable to recall or find its solution. Impatient to get back to the work she had interrupted, I told her to forget about the problem. "It's not that important," I said. She left unconvinced and with an obviously lowered opinion of my problem-solving ability.

A short while later I heard her sobbing in the next room. I went in to see what was wrong. She told me she was ashamed to go to school without a solution to the problem. I invited her into my study and said that this time I would make a "real try." She came skeptically.

I knew, for reasons considered later, that a puzzle is a problem that we usually cannot solve because we make an incorrect assumption that precludes a solution. Therefore, I looked for such an assumption. The first one that occurred to me was that the paper had to remain flat on a surface while the lines were drawn. Once this assumption came to mind and I put it aside, a solution came quickly. I folded the sheet "in" across the middle line of dots and "out" across the bottom line so that the bottom dots fell on top of the dots of the top line (see Figure 1.4). Then, using a felt-tipped pen I drew a line through the top line of dots, holding the pen against the folded edge on which the bottom dots were located. Keeping my pen on the last dot, I unfolded the paper and flattened it. There was a line through the top and bottom rows of dots

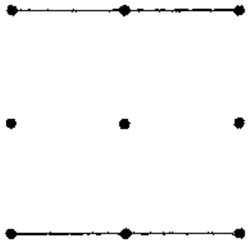


Figure 1.5.

(see Figure 1.5). With three lines left it was easy to cover the remaining dots (see Figure 1.6).

My daughter was delighted with the solution, and her faith in me was partially restored. I returned to my work with more than a little self-satisfaction.

When I returned from work the next day I could hardly wait to hear what had happened in my daughter's class. She returned my greeting as I entered with her usual "Hi" but nothing more. I waited a few moments and then asked, "Well, what happened in your math class?"

"It doesn't matter," she replied, not looking at me.

"Yes it does," I countered. "Now come on, tell me."

"It will only get you mad," she said.

"Maybe it will, but if it does, I will not be mad at you. So tell me."

"Well," she said, "the teacher asked the class who had solved the problem. About five of us raised our hands. She called on another girl who had her hand up and asked her to go to the board and show her solution. She did." My daughter then drew the solution shown in Figure 1.7 on a sheet of paper. It was the solution I had once known but forgotten.

"Then what happened?" I asked.

"The teacher congratulated the girl, told her to return to her seat,

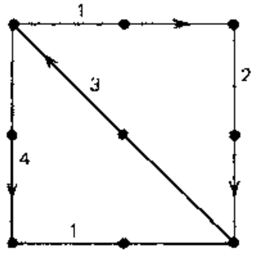
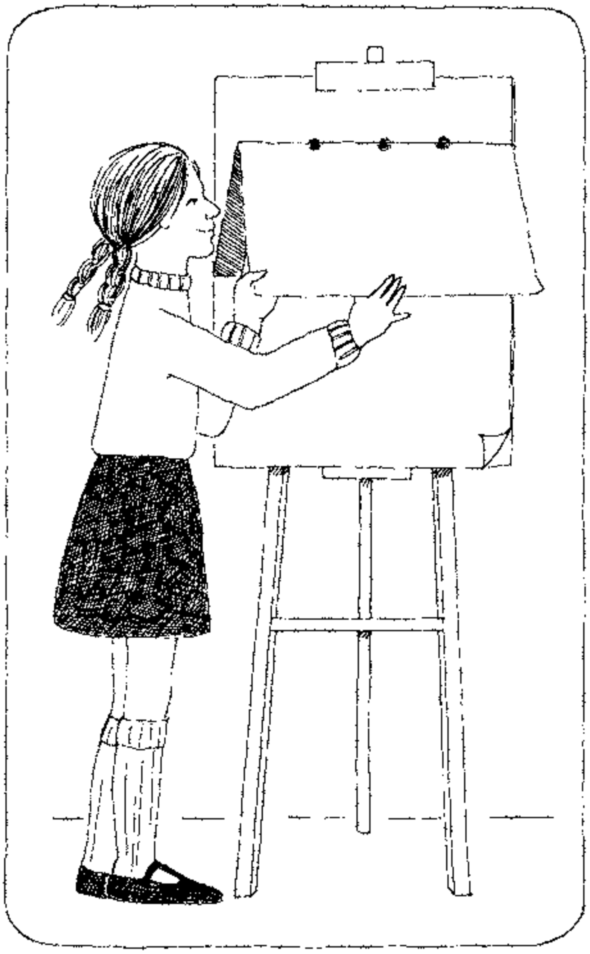


Figure 1.6.



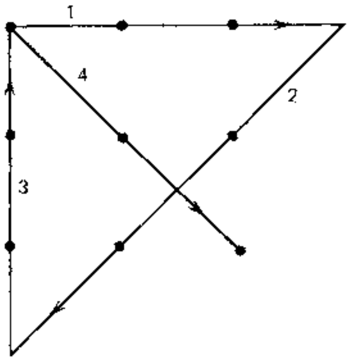


Figure 1.7.

and started to talk about something else. I raised my hand. She stopped and asked me what I wanted. I told her I had a different solution to the problem, one you had given me. She was annoyed but asked me to go to the board and show it to the class. I told her I couldn't show it on the blackboard and needed to use the large pad on the easel in the corner of the room. She told me to go ahead. I drew the nine dots on a blank sheet and started to fold it when she asked what I was doing. I told her I was folding the paper. She told me I couldn't do that. I told her that the instructions didn't say I couldn't. Then she told me she didn't care what the instructions said; that was what she meant. She told me to sit down, so I never got to finish showing the solution."

This is how creativity is suppressed, although usually not so overtly. The teacher made it clear to her class that the objective of the assignment was not to find *a* solution to the problem, but to find *the* solution *she knew* and could pretend to have discovered on her own. She had no interest in any other solution.

Is it any wonder that students become more concerned with what a teacher expects of them in an examination than with what are the best answers to the questions asked?

Imagine what a teacher interested in promoting creativity could have done with the situation involving my daughter. She could have revealed the common property of both solutions: *they broke an assumption that the solver imposed on the problem.* In the teacher's solution the broken assumption was that the lines drawn had to lie within the perimeter of the square formed by the dots. She could then have gone on to encourage the students to find other solutions. Had she done so, one of the students might have discovered how to fold the paper so that *one* line drawn with a felt-tipped pen can cover all the dots (see Figure 1.8).

A puzzle is a problem that one cannot solve because of a *self-imposed constraint.* Creativity is shackled by self-imposed constraints. Therefore, the key to freeing it lies in developing an ability to identify such constraints and deliberately removing them.

It is not enough to become aware of the fact that self-imposed constraints are what obstruct creative problem solving. For example, now that you are aware of this fact, consider this problem.

> **If you have a balance scale, what is the minimum number of weights required to weigh objects of any number of pounds from one to forty?**

Stop here and try to find the solution.

If you are like most people you reasoned somewhat as follows. It is

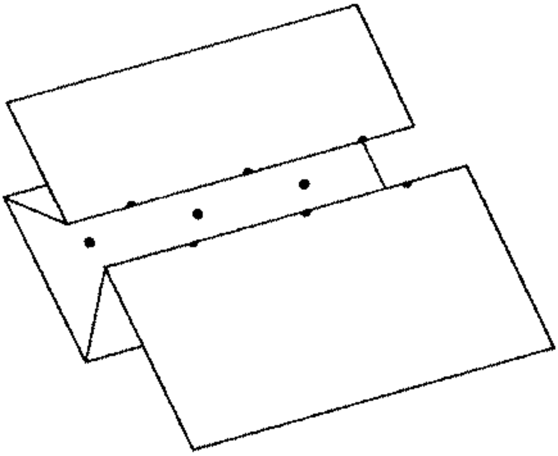


Figure 1.8.

obvious that a one-pound weight is needed to weigh a one-pound object. A two-pound weight is needed to weigh a two-pound object. A three-pound weight is not needed because the one- and two-pound weights can be added. A four-pound weight is needed but not a five (4 + 1 = 5), six (4 + 2 = 6), or seven (4 + 2 + 1 = 7). An eight-pound weight is needed. This will get us up to fifteen pounds. A sixteen-pound weight is needed. This will get us up to thirty-one pounds. Finally, a thirty-two-pound weight is needed, and this will get us up to sixty-three pounds, more than the forty required. Therefore, the answer is six weights (1, 2, 4, 8, 16, and 32).

Wrong! The answer is four weights. Even after giving the right answer, most people cannot see what they missed. In the six-weight solution it was assumed that the object to be weighed must be placed on one side of the balance and the weights on the other, but this is a self-imposed constraint. Objects and weights can be placed on the same side of the scale. Once we "see" this, we find that only one-, three-, nine-, and twenty-seven-pound weights are necessary. For example, to weigh a two-pound object, we place the object and a one-pound weight on one side and the three-pound weight on the other. Similarly, if we put a seven-pound object and a three-pound weight on one side, we can put a nine- and a one-pound weight on the other.

Principles that guide our searches for self-imposed constraints are obviously helpful, but it has been my experience that they do not provide sufficient guidance to creative problem solving. It often takes a bigger push than a principle can provide to get over the hump of a self-imposed constraint. I have found that *examples,* real ones drawn from life, are often more effective because they are likely to be remembered better and longer. Therefore, I use them throughout the book.

The guides to creative problem solving that I suggest are based on an analysis of the nature of problems and an extended experience with management-oriented research projects. Therefore, it may be helpful to reveal the analysis of problem solving from which the suggestions I make are partially derived.

A problem, as I conceptualize it, has five types of component.

1. The one(s) faced with the problem, the *decision maker(s).*

The decision maker may be a group, large or small, or an individual.

2. Those aspects of the problem situation the decision maker can control: *the controllable variables.*

For example, in buying an automobile, the buyer can control such things as the make and model he buys, which accessories he adds, how he finances the purchase, and so on. These variables may be either quantitative (e.g., the number of doors) or qualitative (e.g., the color).

Choice or decision making consists of taking a course of action defined by values of one or more controlled variables. There must be at least two courses of action available, otherwise there is no choice and therefore no problem. There may, of course, be an unlimited number of courses of action available.

3. Those aspects of the problem situation the decision maker cannot control but those which, together with the controlled variables, can affect the outcome of his choice: the *uncontrolled variables.*

These may also be either quantitative or qualitative. Together they constitute the *problem environment.*

For example, the sales taxes on the purchase price of an automobile and the cost of licensing it are not controlled by the purchaser, but they affect the outcome, the cost of the purchase. Note that *un*controlled variables are not necessarily uncontroll*able;* they may be controlled by others. Sales taxes are controllable by legislators. Some uncontrolled variables such as the weather are not subject to anyone's control. Orders for products received by a production department may be out of the control of the production manager, but under the control of the marketing manager. Furthermore, in a hierarchical organization each level controls something that lower levels cannot.

> 4. *Constraints* imposed from within or without on the possible values of the controlled and uncontrolled variables.

For example, the purchaser of an automobile may place a limit on how much he is willing to spend. He may also decide that he will not buy a used car. His choices may also be constrained by what is available at the time of purchase.

> 5. *The possible outcomes* produced jointly by the decision maker's choice and the uncontrolled variables.

For example, he may get either a good car or a "lemon." Note that there must be at least two possible outcomes. If this were not the case, the decision maker's choice would have no effect on the outcome; therefore, his choice would not be a "real" or "meaningful" one. Furthermore, the two or more possible outcomes must be *un*equally desirable; their values to him must be different, otherwise it would not matter to him which outcome occurred.

To one individual there may be no significant difference between the values of two automobiles of the same make and model but of different colors. To another this difference may be of great significance, in fact, critical.

A decision maker tries to select a course of action that produces an outcome he desires, one that is *efficient* relative to what he *values*. Such courses of action are said to be *effective*. Effectiveness is the product of efficiency and value. One who seeks the best, the most effective, course of action is said to *optimize*. One who seeks a solution that is good enough is said to *satisfice*.

In summary, choice exists only (1) when there are at least two possible courses of action available to the decision maker, (2) where there are at least two possible outcomes of unequal value to him, and (3) where the different courses of action have different effectiveness. In other words, choice exists when the action of the decision maker makes a difference in the value of the outcome.

Not every choice situation is a problem situation, but every problem involves a choice. A problem arises when the decision maker has some *doubt* about the relative effectiveness of the alternative courses of action. The solution process is directed at dispelling doubt.

It is apparent that a choice situation that presents a problem to one person may not do so to another because of a difference in their doubts. This is what makes for consultants, experts, advisors, and so on.

In dealing with a problematic situation, a decision maker must develop a *concept*—a representation or a model—of it. He attempts to solve the problem *as he conceives it*. Thus if his conception is wrong, the solution to the problem as conceived may not solve the problem as it exists. A common example is a formulation of a problem that leads to the suppression of symptoms rather than the removal of the cause of a deficiency that creates the problem. Because of such errors of conceptualization, it has often been observed that we more frequently fail to face the right problem than fail to solve the problem we face.

The conception of a problem that I have presented has a general form that can be represented by the equation:

The value of the outcome = A specified relationship
between
the controlled variables
and
the uncontrolled variables.

This equation may be subject to constraints on the controlled and uncontrolled variables.

A problem is said to be *solved* when the decision maker selects those values of the controlled variables which *maximize* the value of the outcome; that is, when he has optimized. If he selects values of the controlled variables that do not maximize the value of the outcome but produce an outcome that is good enough, he has *resolved* the problem by satisficing. There is a third possibility: he may *dissolve* the problem. This is accomplished by changing his values so that the choices available are no longer meaningful. For example, the problem of selecting a new car may be dissolved by deciding that the use of public transportation is better than driving oneself. It may also be dissolved by moving to within walking distance from work so that driving is no longer required. We use "solving" loosely to cover all three alternatives.

Now to the question, What is the meaning of "art" in "the art of problem solving"? Normally, "art" used in this way has nothing to do with aesthetics. For most people aesthetics has no relevance to problem solving. The "art of problem solving" usually refers to both our inability to understand problem solving completely and our ability to make decisions despite this deficiency. This is not the sense in which I use the concept; I use it in its aesthetic sense. To make sense of this I must go back in history.

The philosophers of ancient Greece divided the pursuits of man into four major categories:

1. The scientific—the pursuit of truth
2. The political-economic—the pursuit of power and plenty
3. The ethical-moral—the pursuit of goodness and virtue
4. The aesthetic—the pursuit of beauty

These categories were refined out of the philosophical thought of centuries; they were not the products of a deliberate effort to divide man's activities into exclusive and exhaustive categories. Obviously they are not exclusive, since two or more can be pursued simultaneously. Nevertheless, I believe these categories are exhaustive for reasons discussed later.

It is not surprising that we fail to reflect sufficiently on or fully understand the meaning of "aesthetics of problem solving." Over the last twenty-five centuries very few philosophers have been able to incorporate aesthetics into a comprehensive philosophical system, and there has been little systematic development of aesthetics. On the other hand, aestheticians tend to give the other three categories of man's activities short shrift. As a result, we understand aesthetics much less than science-technology, political economy, or ethics-morality. It is safe to say that most of us have some idea of the way each of these three aspects of our activity relates to the others, but no idea of how any of them relates to aesthetics.

Thoughtful persons would agree that considerable progress has been made in science and technology. Some, but perhaps fewer, would also agree that progress has been made in the domains of political economy and ethics-morality. However, one would be surprised to hear it argued that mankind has made aesthetic progress—that the products of our art are better than those of the ancients or even those of more recent eras.

It has become traditional for affluent people to separate work from play and hence from pleasure. They are conscious of aesthetics—or at least they know of the interaction of beauty, play, and pleasure—in their homes and their recreational and social activities. However, their attitudes toward business and work have been dominated by the Puritan ethic. This ethic contrasts work with play. It conceptualizes work as an *ascetic*, not an aesthetic, activity. Work—and problem solving is considered to be work—is widely thought of as both necessary and necessarily unpleasant. The dissatisfaction it has produced is rationalized by many apologists of the Industrial Revolution who argue that it should be accepted, if not embraced, as a kind of earthly purgatory in which sin is expiated and virtue is gradually accumulated.

It is hardly necessary to point out that, just as fun has been taken out of the work most adults do, it has also been taken out of the learning most children are forced to do. There is little that is beautiful in education.

A principal objective of my effort here is to put beauty and fun back into at least that aspect of work and education we call problem solving.

To understand the meaning of the aesthetics or art of problem solving, we must understand the effort made by philosophers throughout recorded history to find one desire that is both universal and ultimate in terms of which progress can be measured. This has been a search for an ideal shared by all men and women, past, present, and future. Searches for such an ideal failed, ironically, because those conducting the search were too sophisticated. Let me explain.

Once upon a time there was a young man who was granted three wishes. We all know that with the first two he managed to get himself into such a mess that he had to use his last wish to get back to his initial state. On hearing any one of the many versions of this story, most bright children tell us they could do better with only one wish: *they would wish that all their wishes would come true.* My teacher, the much-too-little recognized philosopher Edgar Arthur Singer, Jr. (1948) systematized this childlike wisdom by identifying a desire so universal that it unifies all men at all times. It is the desire for the ability to satisfy desires whatever they may be, even the desire for nothing, Nirvana. It is in the nature of purposeful systems—and people are purposeful systems—to desire, and one can desire nothing without desiring the ability to satisfy it. The ability to satisfy all desires is an ideal necessarily shared by all men at all times. It is called *omnipotence*. Its ideal character is reflected in the fact that virtually every religion ascribes it to deity.

Omnipotence is an ideal that, if it could be attained, would assure fulfillment of all other desires and therefore of all other ideals. Consequently, it is what might be called a *meta-ideal.*

There are four conditions that are necessary and sufficient for the continuous and simultaneous progress of *every* person toward omnipotence.

First, such progress requires a continual increase in the efficiency of the means by which we can pursue our ends and, therefore, a continual incease in our information, knowledge, and understanding—an increase in our grasp of truth. It is the function of science to provide such an increase, and the function of technology to provide an ability to use the products of science effectively.

Second, progress toward omnipotence requires a continuous increase in the availability of and access to those resources needed to employ the most efficient means available. Availability implies a state of plenty and access implies a state of power. To provide these is the function of the political economy.

Third, it requires continuous reduction of conflict within and between individuals, because conflict means that the satisfaction of one (or one's) desire precludes the satisfaction of another (or another's) desire. Therefore, we pursue both peace of mind and peace on earth, a state of goodness and virtue. This pursuit is ethical-moral.

Finally, it requires the aesthetic function. This is the most difficult to understand.

If man is to continually pursue the ideal of omnipotence, he must never be willing to settle for anything less; that is, he must never be either permanently discouraged or completely satisfied. Whenever he attains one objective, he must then start after another that is even more valuable to him, and he must seek a continual increase in his ability to satisfy his desires. Therefore, he must always be able to find new possibilities for improvement and satisfaction. He must always be able to generate visions of a more desirable state than the one he is in.

E. A. Singer, Jr. (1948) showed that it is the function of art to provide such visions and to *inspire* us to their pursuit: to create the creator of visions of the better and to give this creature the courage to pursue his visions no matter what short-run sacrifices are required. Inspiration and aspiration go hand in hand. *Beauty* is that property of the works and workings of man and Nature that stimulates new aspirations and commitments to their pursuit. No wonder we say of a solution to a problem that inspires us, "it is beautiful."

Long before Singer, Plato conceived of art as a stimulant that was potentially dangerous to society because it could threaten society's stability. His conception of the disquieting function of art is the same as that put forward here, but his conception of utopia, his *Republic,* as a stable state is not. There is at least as much satisfaction to be derived from the pursuit of objectives as in attaining them, and from the pursuit of solutions to problems as in attaining them. Therefore, in an ideal state, as I conceive it, man would not be problem free, but he would be capable of solving a continual flow of increasingly challenging problems.

Of greater importance is the fact that an ideal state is not attainable whatever its characteristics; therefore, in all less-than-ideal states such disquiet as Plato sought to control is required if continual progress toward the ideal is to be made.

In contrast to Plato, Aristotle viewed art as cathartic, a palliative for dissatisfaction, a producer of stability and contentment. Whereas Plato saw art as a producer of dissatisfaction with the present state of affairs that leads to efforts to create a different future, Aristotle saw it as a producer of satisfaction with what has already been accomplished. Plato saw art as *creative* and Aristotle saw it as *recreative*.

These are not different things but two aspects of the same thing. Art is both creative and recreative. These aspects of it can be viewed and discussed separately, but they cannot be separated. Recreation is the extraction of pleasure here and now, a reward for past efforts. It provides "the pause that refreshes" and by so doing *recreates the creator*. Art also produces an unwillingness to settle for what we have. It pulls us from the past and pushes us into the future.

Thus, to make problem solving creative (inspiring) and fun (recreative) is to put art into it. To do so is to reunite work, play, and learning and therefore to reunify man, at least in his problem-solving activities.

So much for my concept of the nature of problem solving and the art on which this guide is based.

Using the conception of a problem set forth above we can consider problem solving with respect to what the decision maker does about each of these components:

1. Objectives: desired outcomes
2. Controlled variables: courses of action
3. Uncontrolled variables: the environment
4. The relationships among these three

Since constraints apply to each of these, they need not be treated separately.

As stated previously, the principles presented are illustrated by a number of cases; I can vouch for most of them. A few are second hand or more, but the possible inaccuracies in my account of these cases in no way detracts from their usefulness as examples of the principles. As one of my friends said about these examples, "If they are not true, they ought to be." The reader may treat all the short illustrations as fictional. To assist him in doing so I present them in a form that one of my students named *Ackoff's Fables*. In these fables I use "Aesop," appropriately I hope, as a pseudonym for the creative problem solver.

Not all the fables have happy endings; they are not all success stories. Creative solutions are often not accepted. This is not surprising in view of the widespread resistance to change, particularly to something new and unconventional. Because of such resistance the creative problem solver is not likely to be successful unless he is also competent, communicative, concerned, and, most of all, courageous.

One final note: many of the cases used here have been used in previous writings but in different forms and for different purposes. Therefore, those few readers who may have read any of my previous books may recognize some of the stories. I hope they will be greeted as old friends rather than redundant bores.