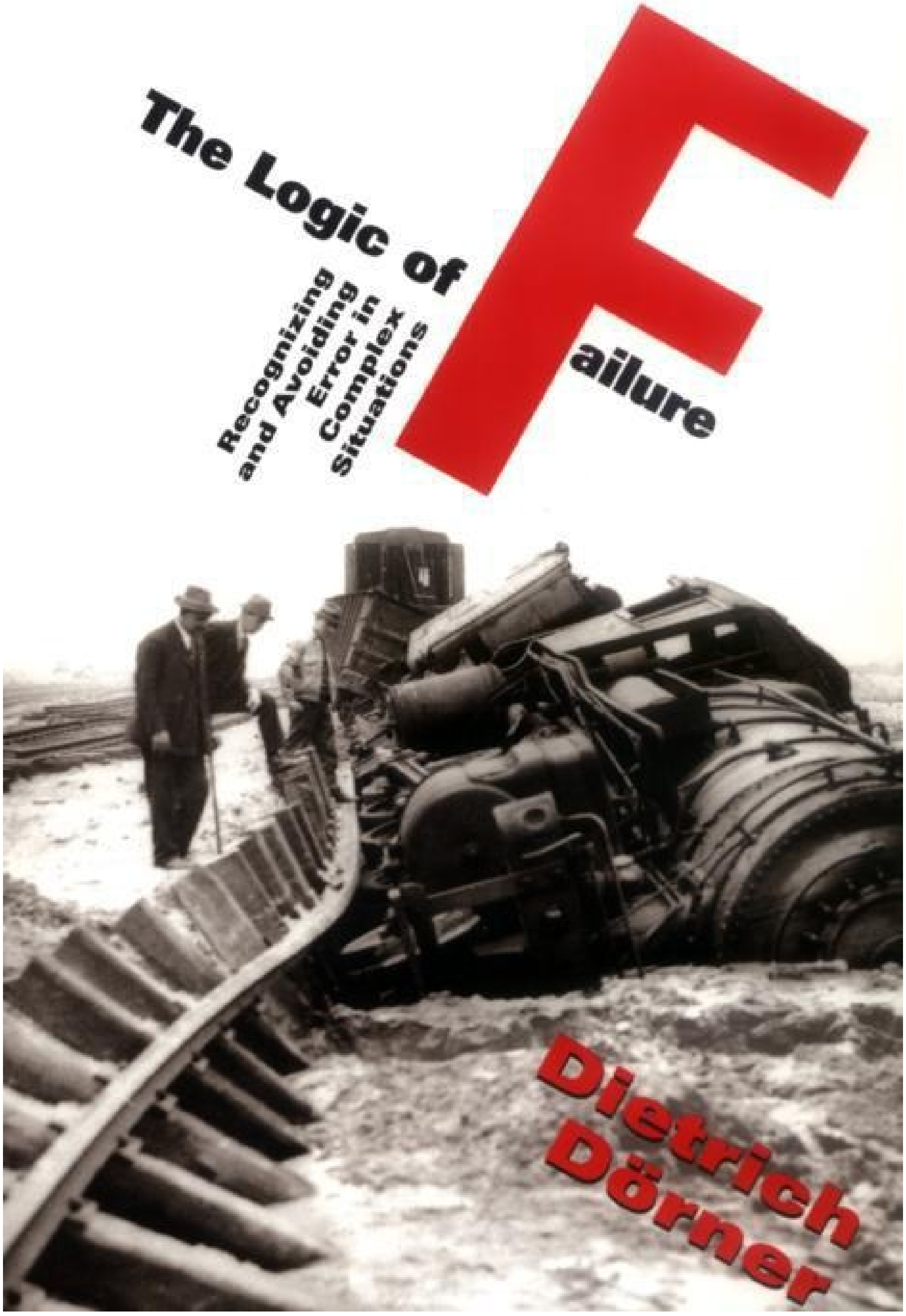
The Logic of Failure

Recognizing and Avoiding Error in Complex Situations

Dietrich Dörner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Translated by Rita and Robert Kimber

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A Merloyd Lawrence Book

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Praise for

The Logic of Failure

"Dietrich Dorner is an internationally respected figure in the field of cognitive behavior. What revolutionary about Mr. Dorner's analysis is his conclusion that not understanding how ou actions will affect the world around us is, in its way, almost rational. Failure has its own kind o logic... Mr. Dorner's work helps us understand how good intentions come to naught and how ou minds-one wants to say our natures-substitute managing the minutiae of bureaucracy and publ policy for grappling with concrete human problems.... Mr. Dorner refrains from drawing politic conclusions, however, hewing closely to the hard facts of his scientific research."

-The Washington Times

"This ingenious manual will assist problem solvers in all fields."

-Publishers Weekly

"Dorner, a winner of Germany's highest science prize, the Leibniz Award, makes his contributio to the study of complexity by demonstrating just how difficult and problematic decision makin can be. Happily, his methodology is both elegant and revealing.... The implications here a substantial, for he has created a basic blueprint for testing decision-making skills and a broa model for improving them .... A provocative and important road map for years of future scientif experiment and investigation."

-Kirkus Reviews

"Unprecedented computer-simulated research....a fascinating read!

-Stephen Covey, author of The Seven Habits of Highly Successful People

"Quick, somebody give Bill Clinton... copies of The Logic of Failure. Hand them to CEOs of th Business Week 1000, while you are at it. Everybody knows that people in authority make dum mistakes. Dietrich Dorner explains why they do so, drawing on psychological experimen conducted via computer simulations with role-playing volunteers. Readers will recogni themselves or colleagues in the volunteers .... Dorner believes that guided role-playing can he people understand what they are doing wrong and get better at making decisions. Writes Dorne `Anybody who thinks play is nothing but play and dead earnest is dead earnest hasn't understoo either one.'"

-Business Week

"Dorner, a professor at the University of Bamberg and director of the cognitive anthropolog project at the Max Planck Institute in Berlin has impeccable credentials in this special branch cognitive psychoanthropology. And lie graces us with the nicest title so far. His lively treatis accessible to the cultivated lay reader, capitalizes on real-life cases and refined ad ho experiments... Lucid, well-balanced, wellsupported and instructive."

-Nature

"One of the best management titles of the year, this is a necessary addition to both psycholog
and management collections of all types."

-Library Journal

An especially important book that deals with the nature and origins of mistakes in a way that h
no precedent."

-James Reason, author of Human Error

"Plenty of humor and fascinating anecdotes in a serious yet enjoyable book."

-The New Scientist

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Acknowledgments

Anyone who has ever written a book knows that one doesn't write it alone.

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Translating a book, assuming it is not simply a technical manual, essentially means rewriting i The translators in this case have, I feel, succeeded admirably at that creative task, and I would like thank Rita and Robert Kimber for their able rendering of this text. They have managed to preserve the translation that quality which is so hard to define and grasp: the "spirit" of the original.

I would also like to express my heartfelt appreciation to my editor at Metropolitan Books, Sa Bershtel, for the skill, patience, and care with which she has seen this difficult project through to i conclusion. My thanks as well to Diana Gilooly and Roslyn Schloss for their thorough and sensitiv work on this manuscript.

And finally I would like to remember Bjela, with all gratitude.

D.I

Introduction

We were in high spirits. The physicist laughed as he told his story: "Everybody had agreed o the proposed plan. The mayor had the support of both the citizens and the city council. Because th volume of traffic downtown and the resultant noise and air pollution had become intolerable, th speed limit was lowered to twenty miles per hour and concrete "speed humps" were installed prevent cars from exceeding it.

"But the results were hardly what the planners anticipated. The lower speeds forced cars to travel second rather than third gear, so they were noisier and produced more exhaust. Shopping trips th used to take only twenty minutes now took thirty, so the number of cars in the downtown area at an given time increased markedly. A disaster? Noshopping downtown became so nerve-racking tha fewer and fewer people went there. So the desired result was achieved after all? Not really, for eve though the volume of traffic gradually went back to its original level, the noise and air pollutio remained significant. To make matters worse, during the period of increased traffic, word had gotte around that once-a-week shopping expeditions to a nearby mall on the outskirts of a neighboring tow were practical and saved time. More and more people started shopping that way. To the distress of th mayor, downtown businesses that had been flourishing now teetered on the verge of bankruptcy. Ta revenues sank drastically. The master plan turned out to be a major blunder, the consequences o which will burden this community for a long time to come."

The fate of this environment-conscious town demonstrates how human planning and decisio making processes can go awry if we do not pay enough attention to possible side effects and long-ter repercussions, if we apply corrective measures too aggressively or too timidly, or if we igno premises we should have considered. Effective planning and decision making were what the physici and his economist colleague had on their minds this pleasant summer morning as the three of u walked down a hall at the University of Bamberg. The two men had come from a large, well-know industrial enterprise, and their mission was to acquaint themselves with the computer-simulate planning games my colleagues in the psychology department and I had developed and to see wheth these games might be of use to them in their company's training program. Our initial conversation w a general one about the failings of human thought and action, and implicit in it, of course, was th arrogant belief that such failings are always to be found in other people-in the mayor of a small tow for example, or in the managers of a large corporation whose business policies have brought the company to the brink of bankruptcy, or in the directors of public organizations who misdirect fund The unspoken assumption in conversations like these is always that we could do much better given th opportunity.

A couple of hours later the mood had deteriorated noticeably. The two visitors had, in that perio worked through a planning game. The task was to create better living conditions for the Moros, a We African tribe of seminomads who wander from one watering hole to another in the Sahel region wi their herds of cattle and also raise a little millet. Things were not going particularly well for them Infant mortality was high and life expectancy was low; their economy was decimated by repeate famines; tsetse flies ravaged their cattle, preventing any significant increase in herd size. In shor ~~their situation was dreadful. But now there were solutions. Money was available. Measures could b~~ taken against the tsetse fly; deeper wells could be drilled to improve irrigation and allow an expansio of pastureland; fertilizers and the planting of different strains of millet could improve crop yield; health service could be established. There was no end to what could be done for the Moros, at least our computer-simulated Sahel.

The economist and the physicist went to work with a will. They gathered information, studied th map of the Moro region intently, asked questions, considered possibilities, rejected one set of plan developed new ones, and finally reached some decisions that were fed into the computer. The machin then calculated the effects those decisions would have.

Years sped by in minutes. The computer worked like a kind of time machine. After twent (simulated) years and two (real) hours the physicist politely, but with unmistakable irritation, calle the economist's attention to the simulator's report of reduced yield from the Moros' wells. "My de colleague, it was my opinion from the outset that all this drilling of deep wells was a bad idea, an back in year 7 of the simulation I said so in no uncertain terms."

The economist responded with barely disguised annoyance. "I don't recall that at all. On th contrary, you were still suggesting the most efficient ways to drill deep wells. And, incidentally, you ideas on health care haven't turned out to be particularly brilliant either."

The reason for this clash was the truly dismal state of the Moros, whose standard of living improve at first, only to decline again quite rapidly. In the two decades of simulation, the Moro population ha doubled. Thanks to an excellent health-care system, mortality-and infant mortality in particular-ha dropped sharply. Initially, too, there had been a great increase in the number of cattle, thanks t successful suppression of the tsetse fly. At the same time, the drilling of numerous deep wells mad available a rich supply of groundwater that allowed the Moros to enlarge their pastureland radicall Eventually, however, the pasturage was no longer able to support the large herds, and overgrazin occurred. The hungry cattle tore up the grass roots; the vegetated land area shrank. And by year 2 hardly any cattle were left, because the pastures were almost completely barren. The drilling of sti more wells, helpful in the short term, had exhausted the remaining groundwater supply all the mo rapidly. The Moros were now in a hopeless situation that could only be alleviated by a massiv infusion of outside aid.

How could this have happened? Our two academically trained game players were not, of cours specialists in aid to developing countries. On the other hand, they considered themselves quite capab of dealing with the given problems, and they certainly had the best intentions. Nevertheless, the made terrible decisions. They drilled wells without considering that groundwater is a resource th cannot easily be replaced. They set up an effective health-care system, reducing infant mortality an increasing lifespan, but did not institute birth-control measures. In short, they solved some immedia problems but did not think about the new problems that solving the old ones would create. They no had to feed a significantly larger population with significantly reduced resources. Everything w much more complicated than before. If no outside help had been available, the result would have bee a massive famine.

It is important to note that the Moro planning game does not involve any tricks. No particul technical expertise is required to play it. Everything that happens is really quite obvious. If you dr wells, you will deplete groundwater. And if the water is not replaced (and how can groundwater b repl~~aced in any significant amount on the southern border of the Sahara?), it will be gone. That~~ fact easy enough to see-in hindsight. Failures in the Moro planning game evoke dismay in the observ precisely because the cause-and-effect relationships are so simple. No one is distressed by failing see very subtle points that require specialized knowledge. We are distressed, however, if we overloo the obvious. And that was the case here.

The outcome of the Moro planning game illustrates the difficulties even intelligent people have dealing with complex systems. The economist and the physicist were by no means worse planners tha other people. Their actions were no different from those of "experts" in real situations.

Consider an actual disaster that occurred in southern Africa, the unintended result of a project combat hunger in parts of the Okavango delta.' Scientists had outlined a simple plan: the tsetse f would be repressed and the herds of wild animals in the region would then be replaced by beef cattl At first everything went well. Soon, however, hundreds of additional cattle herders moved into th area. Overgrazing and drought quickly turned the originally habitable land into a desert.

Like the Moros, we face an array of closely-though often subtlylinked problems. The modern wor is made up of innumerable interrelated subsystems, and we need to think in terms of the interrelations. In the past, such considerations were less important. What did the growth of Lo Angeles matter to a Sacramento Valley farmer a hundred years ago? Nothing. Today, howeve aqueducts running the length of the state make northern and southern Californians bitter competito for water. Of what concern to us were religious differences in Islam forty years ago? Apparently non The global interrelations of today make such dissension important everywhere.

It appears that, very early on, human beings developed a tendency to deal with problems on an a hoc basis. The task at hand was to gather firewood, to drive a herd of horses into a canyon, or to bui a trap for a mammoth. All these were problems of the moment and usually had no significance beyon themselves. The amount of firewood the members of a Stone Age tribe needed was no more a threat the forest than their hunting activity was a threat to wildlife populations. Although certain anim species seem to have been overhunted and eradicated in prehis toric times, on the whole o prehistoric ancestors did not have to think beyond the situation itself. The need to see a proble embedded in the context of other problems rarely arose. For us, however, this is the rule, not th exception. Do our habits of thought measure up to the demands of thinking in systems? What erro are we prone to when we have to take side effects and long-term repercussions into account?

These questions are especially pertinent when we address such problems as environment degradation, nuclear-weapons buildup, terrorism, and overpopulation. Like the attempt to help th Moros, efforts to deal with these dangers have created new problems or exacerbated old ones. Th seeming failure of our capacity to think has prompted sweeping criticism of the human intellect, if n for the existence of our problems, then at least for our inability to solve them. The theories advance are grandiose and run the gamut from genetic to evolutionary to culturally determined.

Some analysts complain that all our difficulties stem from the fact that we have been turned loo in the industrial age equipped with the brain of prehistoric times.'- They see our tendency to think simple chains of cause and effect as genetically preprogrammed and locate our inability to solve o problems in this genetic programming. Others note the conditions that evolution has placed on th development of the human cognitive apparatus.' The claim is that we have a strong tendency visualize when we form hypotheses about the world and events that take place within it and that o ~~minds therefore have great difficulty grasping problems that cannot be visualized. Still other~~s hav located the source of the trouble in male domination of society. They distinguish between "seria male thinking and "parallel" female thinking and identify the latter as more appropriate for dealir with complex problems. Indeed, the entire tradition of Western "analytical" thinking is often blame for all our woes.

Many popular authors have gone beyond complaint and offered sweeping cures. Some are based o mysterious new regimens of thinking and learning. Several years ago, for example, a best-selling boo elu cidated a method that would teach us how to think in two weeks. Another book promises to teac us "new thinking" but maintains a strict silence on what this so-called new thinking really is.' Mar individuals and institutions publicize the benefits of courses in "creative thinking," brainstormin synectics, the 3-W method, the Q5P method, and so on. Companies recommend (and sel "superlearning." We can even, we are told, vastly increase our cognitive powers by learning in ou sleep.

Other cures rely on facile theories about the human brain: that we use only 10 percent of o intellectual potential and we must tap into the other 90 percent; that the brain can be mapped into re green, and white sectors and we must make greater use of the green parts of our brains than we have the past; or that the right and the left halves of the brain have different functions and we must re more on the right half.

What should we make of all this? The probability that there is a secret mental trick that at or stroke will enable the human mind to solve complex problems better is practically zero. It is equal unlikely that our brains have some great cache of unused potential. If such things existed, we would l using them. Nowhere in nature does a creature run around on three legs and drag along a fourt perfectly functional but unused leg. Our brains function the way they function and not otherwise. W must make the best of that; there is no magic wand or hidden treasure that will instantly make us dee and powerful thinkers.

Real improvement can be achieved, however, if we understand the demands that problem solvir places on us and the errors that we are prone to make when we attempt to meet them. Our brains a not fundamentally flawed; we have simply developed bad habits. When we fail to solve a problem, v fail because we tend to make a small mistake here, a small mistake there, and these mistakes add u Here we have forgotten to make our goal specific enough. There we have overgeneralized. Here v have planned too elaborately, there too sketchily.

The subject of this book is the nature of our thinking when we deal with complex problems. describe the kinds of mistakes human beings make, the blind alleys they follow down and the detou they take in attempting to cope with such problems. But I am not concerned with thinking alone, f thinking is always rooted in the total process of psychic activity. There is no thinking witho emotion. We get angry, for example, when we can't solve a problem, and our anger influences ou thinking. Thought is embedded in a context of feeling and affect; thought influences, and is in tu influenced by, that context.

Thought is also always rooted in values and motivations. We ordinarily think not for the sake o thinking but to achieve certain goals based on our system of values. Here possibilities for confusio arise: the conflict between treasured values and measures that are regarded as necessary can produ some curious contortions of thought-"Bombs for Peace!" The original value is twisted into i opposite. ~~Motivations provide equally ambiguous guidelines. There are those who would say tha~~t wh counts are the intentions behind our thinking, that thought plays only a serving role, helping u achieve our goals but failing to go to the root of the evils in our world. In our political environment, would seem, we are surrounded on all sides with good intentions. But the nurturing of good intentio is an utterly undemanding mental exercise, while drafting plans to realize those worthy goals another matter. Moreover, it is far from clear whether "good intentions plus stupidity" or "ev intentions plus intelligence" have wrought more harm in the world. People with good intentio usually have few qualms about pursuing their goals. As a result, incompetence that would otherwis have remained harmless often becomes dangerous, especially as incompetent people with goo intentions rarely suffer the qualms of conscience that sometimes inhibit the doings of compete people with bad intentions. The conviction that our intentions are unquestionably good may sancti the most questionable means.

Good intentions pursued in the name of goodness, then, are no guarantee. Our physicist and o economist were eager to construct a happy future for the Moros. The result? They set goals, they acte on them, and they failed. Why? Surely neither was responsible; nor did ei ther fail out shortsightedness or incomplete understanding of the situation. How could he have? After all, he ha the best of intentions. It was the other guy's fault. He fouled up the works. That stupid idea of drillin deep wells was his! In the laboratory, we can undo the messes we make. In the real world, that's not s easy.

Because our thinking, with its subtle interplay of emotion and calculation, conscience and ambitio reflects the richness of the world around us, experiments to determine the characteristics of huma planning and decision making in complex situations should, ideally, draw on reality. We should stud a large number of actual cases-the planning and actions of real politicians, organizational director and corporate officers, for example. But such a project runs into difficulties. Only isolated cases a available for study, and we cannot generalize from so few examples. Furthermore, real-wor decision-making processes are rarely well documented, and it is hard, if not impossible, to reconstru them. Reports on real processes of this kind are often unintentionally distorted or even intentional falsified.

Fortunately, computer technology allows us to simulate almost any complex situation we migh wish to study, from the flora and fauna of a garden pond to the social interactions in a small city. Th flexibility of computer scenarios allows psychologists and other social scientists to exami experimentally processes that were previously observable only in isolated cases. Of course, scenar situations always have the quality of a game. The situations in a computer are not real-ba administrators do not starve whole countries, and incompetent mayors are not run out of town. Th fact is, however, that our participants usually took our "games" very seriously. In any case, this boo provides many opportunities to reflect on what in our results should be taken in earnest and what no Grim parallels to actual events raise the question, for example, of whether we should dismiss as macabre joke one participant's proposal to shoot any worker whose machine turned out faul products.

Computer simulations also enable us to observe and record the background of planning, decisio making, and evaluation processes that are usually hidden. It is easier to isolate the psychologic determinants of such processes this way than it is to investigate them retrospectively in the real worl

In recent years, my colleagues and I have used these computer games extensively to study proble solving by individuals and groups. In this book, I present and interpret some of our findings in order illuminate the psychological factors bearing on human planning and decision making.

Failure does not strike like a bolt from the blue; it develops gradually according to its own logic. A we watch individuals attempt to solve problems, we will see that complicated situations seem to elic habits of thought that set failure in motion from the beginning. From that point, the continuin complexity of the task and the growing apprehension of failure encourage methods of decision makin that make failure even more likely and then inevitable.

We can learn, however. People court failure in predictable ways. Readers of this book will fin many examples of confusion, misperception, shortsightedness, and the like; they will also find that th sources of these failings are often quite simple and can be eliminated without adopting a revolutiona new mode of thought. Having identified and understood these tendencies in ourselves, we will b much better problem solvers. We will be more able to start wisely, to make corrections in midcours and, most important, to learn from failures we did not avert. We need only apply the ample power o our minds to understanding and then breaking the logic of failure.

One

Some Examples

The Lamentable Fate of Tanaland

Tr~ analand is a region in West Africa (see fig. 1). Through the middle of Tanaland flows th Owanga River, which widens out into Lake Mukwa. On the shores of Lake Mukwa is the town o Latnu, surrounded by orchards, gardens, and forests. In and around Lamu live the Tupis, an agraria tribe. The northern and southern parts of the region are steppes. The Moros, nomadic herders wh subsist on hunting and on the sheep and cattle they raise, live in the north in the area around the sma town of Kiwa.

Tanaland is not a real place. It exists only in the computer, which simulates its natural features, i populations of humans and animals, and their interdependence.

We gave twelve participants in this experiment the task of promoting the well-being of Tanaland inhabitants and of the entire region. The participants had dictatorial powers. They could carry out ar measures they liked without opposition. They could impose hunting regulations, improve th fertilization of the fields and orchards, install irrigation systems, and build dams. They could electri the entire region and mechanize it with the purchase of tractors. They could introduce birthcontr measures and improve medical care. They had a total of six opportunities, scheduled at intervals their own choosing, to gather information, plan measures, and reach decisions. With these s "planning sessions," they would determine the fate of Tanaland over a period of ten years. At each o the planning sessions, the participants could implement as many measures as they cared to. And each new planning session, they could take into account the successes and failures of previous phas and cancel or modify earlier decisions.

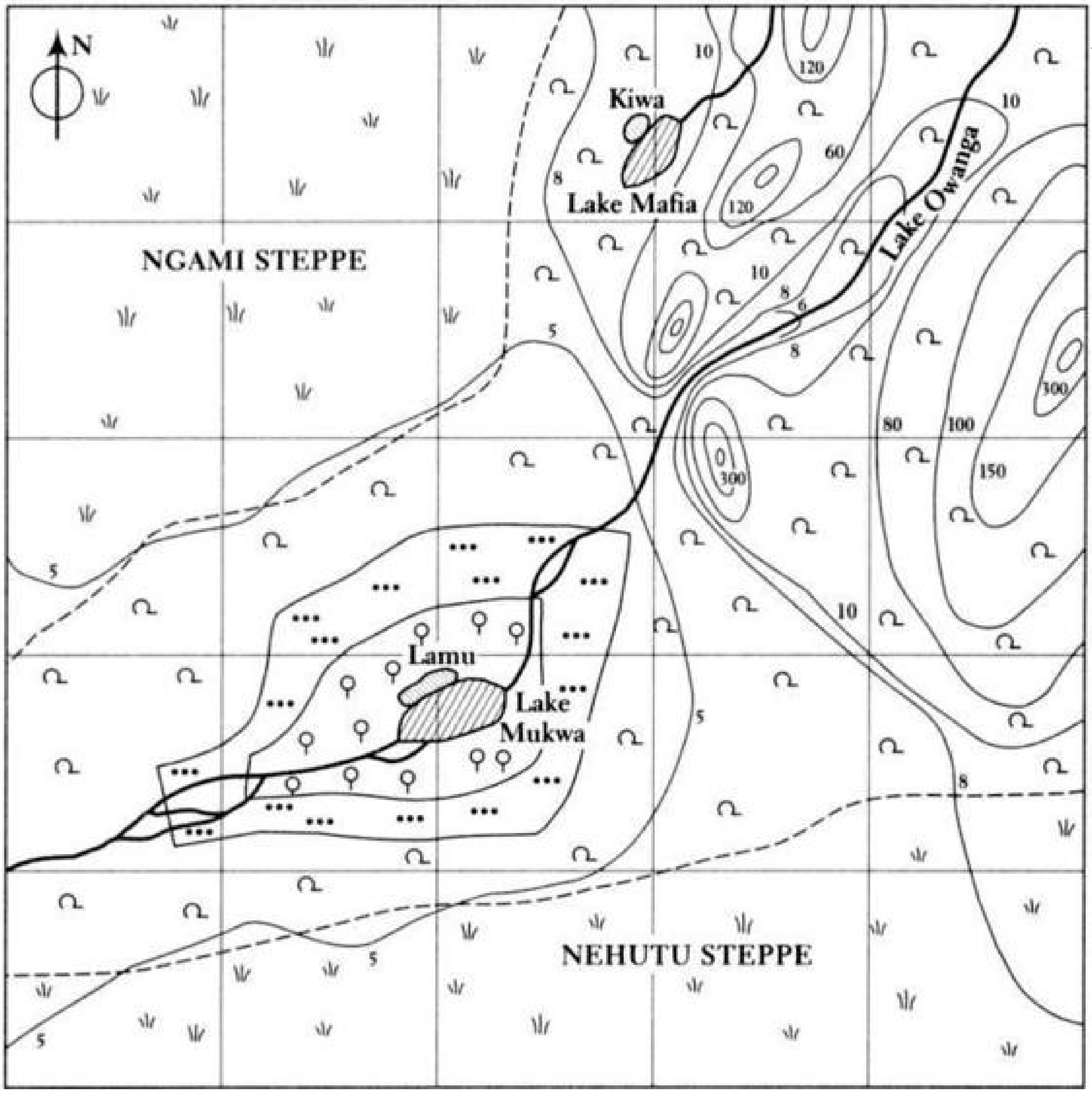


Fig. 1. Tanaland

Figure 2 shows the results of an average participant's governance over the ten years (or 1 months). We see that the population of the Tupis (the agrarian people) increased at first. An improve food supply and good medical care account for that. The number of children grew; the number deaths declined. Life expectancy was higher. After the first three sessions, most participants thoug they had solved Tanaland's problems. It did not occur to them that their measures had in fact set time bomb ticking, and they were taken by complete surprise when the almost inevitable famin broke out in later years.

For our average participant in figure 2, a catastrophic famine that could not be reversed occurred about the eighty-eighth month. It did not affect the Moro herdsmen, who had remained at a lower lev of development, nearly as drastically as it did the Tupis, upon whoa; the blessings of artifici fertilizers and of medical care had been visited in full force. The old pattern had repeated itsel existing problems (in this case, inadequate food supply and medical care) had been solved with o thought for the repercussions and the new problems the solutions would create.

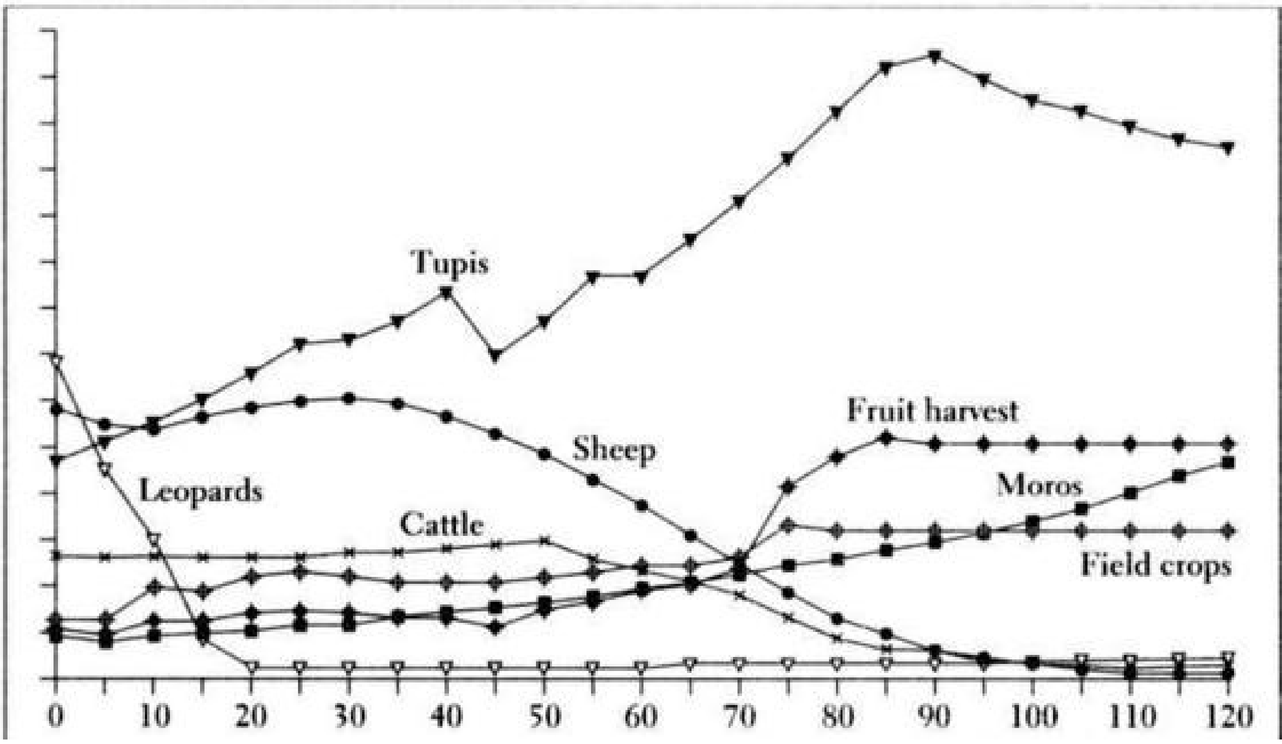


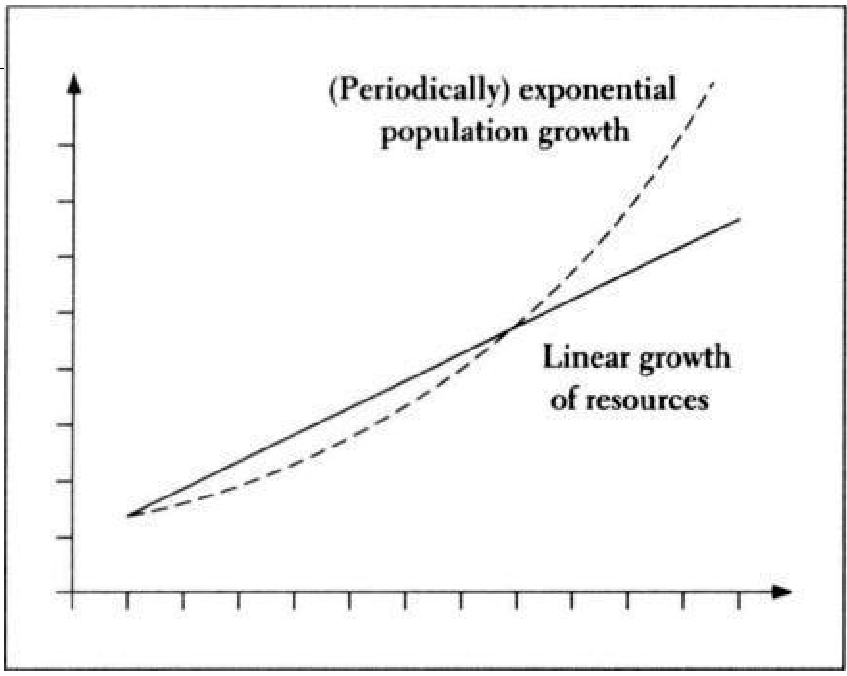
Fig. 2. Results achieved by an average participant in the Tanaland experiment

Catastrophe was inevitable because a linear increase in the food supply was accompanied by a exponential increase in the population. Figure 3 shows the parallel development of these two factor At first, thanks to artificial fertilizers and the deeper plowing made possible by motorization, the foo supply clearly exceeded the demand. The increase in population was slower in starting, but then quickly outran the food supply. Catastrophe was the inevitable result.'

Things could have gone differently. Figure 4 shows the results obtained by a different participa and suggests that a stabilization of conditions in Tanaland was possible. This participant achieve (with no little difficulty) a stable population and an overall improvement in the standard of livin results that differ dramatically from those of our average participant, whose initially very positiv impact on Tanaland was followed by a disastrously negative one.

What were the reasons for success and failure? The "good" participant did not possess any experti that the others lacked. Tanaland did not pose any problems that could be solved only with the help o specialized knowledge. The explanations for success and failure lie instead in certain patterns thought. In a system like Tanaland's, we cannot do just one thing. Whether we like it or not, whatev we do has multiple effects.

Fig. 3. Catastrophe trap: linear growth of resources and exponential population growth



For example, one reason that Tanaland's fields and gardens are so unproductive is that mice, rat and monkeys eat much of the crops. The obvious solution is to reduce the numbers of these pes drastically by hunting, trapping, and poisoning. Initially, extermination of the rodents and monkey improves the yields from farms and orchards. But at the same time the decrease in small mamma brings about an increase in the insects the small mammals also feed on. And then there are the region large predatory cats; deprived of the small mammals that are their prey, they take to feeding on catt instead. Thus, it is possible that attempting to eliminate the rodents and monkeys will be not mere useless but actually harmful. Failure to anticipate side effects and long-term repercussions of this kin was one reason for the failures that most of our participants produced in Tanaland.

There are other reasons as well. Figure 5 compares the frequency with which participants engage in three types of activity: making decisions, reflecting on the overall situation and on possible cours of action, and asking questions. During the six sessions of the experiment, we used these categories track the thinking out loud that our participants did; the chart shows that the relative frequency of th three activities changed over time. At the first session, orientation activities-questioning an reflection-clearly predominate. About 56 percent of all the recorded activities fall into these tw categories. Decisions reached account for about 30 percent. Other categories account for th remaining 14 percent.

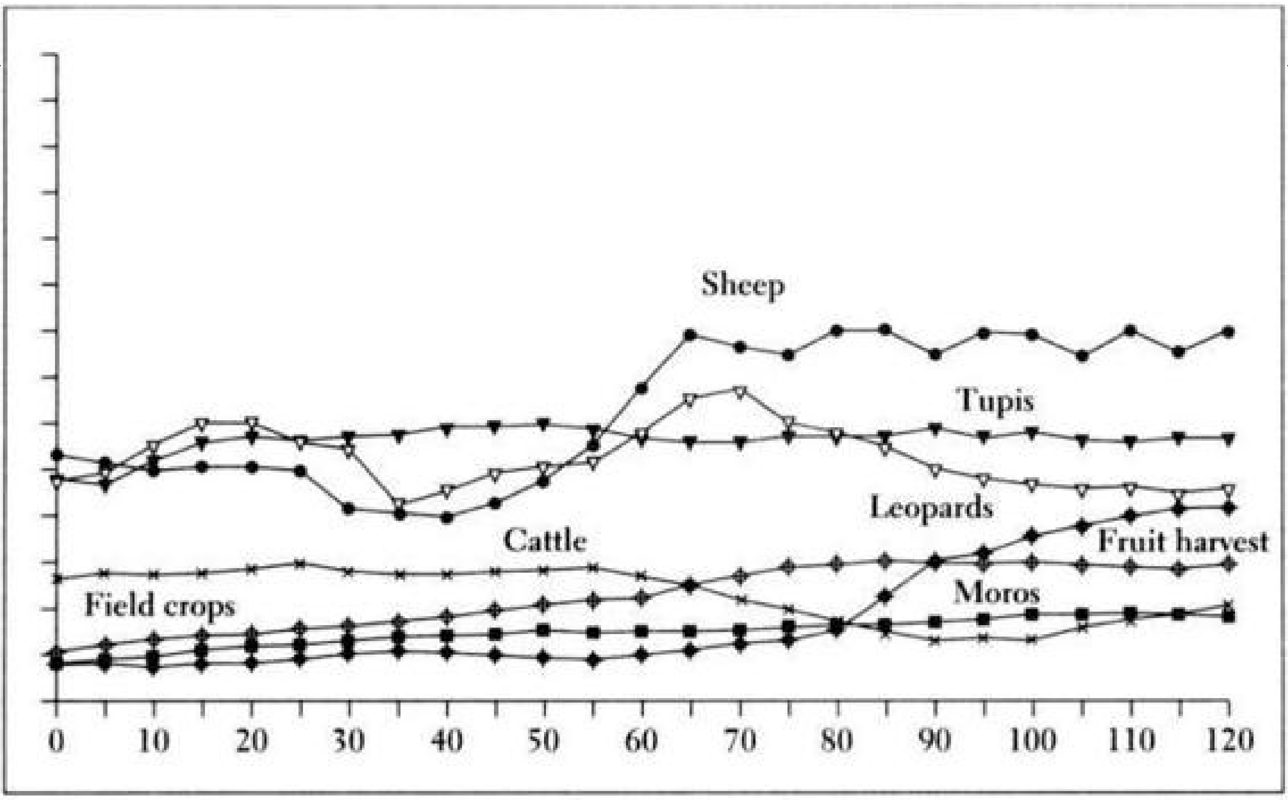


Fig. 4. Results achieved by the only successful participant in the Tanaland experiment

After the first session, however, the picture changes dramatically. Activities associated wit analysis of the situation become fewer; those associated with decisions increase steadily. Over th course of the six sessions, our participants clearly evolved from hesitant philosophers to men ar women of action. The participants apparently felt that their initial questioning and reflection gav them a sufficiently accurate picture of the situation, one requiring no further correctives, whether b gathering additional information or by reflecting analytically on results achieved. They though mistakenly, that they already had the knowledge they needed to cope with Tanaland's problems.

Fig. 5. Decisions, reflection, and questions: the development in the course of six meetings

sample content of The Logic Of Failure: Recognizing And Avoiding Error In Complex Situations