DECISION LENS

This is an Excerpt from **Group Decision Making: Drawing Out and Reconciling Differences** by Thomas L. Saaty, Kirti Peniwati

# PART I: The Group and the Decision

There is strength in numbers, the saying goes. When a group makes a decision, that decision carries a lot more weight than when just one person does it. Think of the founding fathers of the American constitution and how much power and influence their ideas have had in the entire world for more than two hundred years. Also think of gravity, a universal force brought about by an enormous number of minute particles that band together to make a universal law. Together, they create a massive force, a law of nature; alone they can barely be noticed. That is how our minds work by deciding together to create a power that transcends our individuality. Group decision making is a gift and an opportunity to create greater influence through the working together of many minds.

There exists perhaps no better example of the pressing need for synthesizing a group's decision making into a unified judgment than the American dilemma in Iraq in late 2006 and early 2007. While the president spoke continuously of victory, Iraq suffered the continuous trauma of sectarian violence. Many generals, members of Congress, Iraqi politicians, and the American majority had expressed their opposition to the war – especially in the November 2006 elections. Even the president himself and his advisers advocated new alternatives in Iraq ranging from an immediate and complete withdrawal of troops to increasing the number of American soldiers deployed to Iraq by tens of thousands. The ability to resolve this kind of chaos is not only desirable but essential in our day.

For another example, consider the issue of investment in different securities whose future is projected by numerous people with varied experience using different techniques. How do we combine their different predictions into a credible overall prediction depending on the priorities of the contributors and their techniques? A hierarchical model of portfolio management can include three separate hierarchies: one based on extrinsic factors, one based on intrinsic factors, and a third based on the investor's objectives. The extrinsic factors are the outside economic, political, social, and technical factors or environmental characteristics that affect an industry's (or firm's) performance and on which a firm has no direct influence. The intrinsic factors are the internal factors or operational characteristics of the firm such as profitability, size, technology, and philosophy. They may be considered as a measure of the way the firm is making its decisions or, in general, a measure of the firm's capacity to compete successfully. The investor's objectives include such factors as profitability, security, excitement, and control. Knowledge about the importance of all the factors affects the way the investment is made. Different people have different ideas about what is important and how

important it is. Usually we can't say that any one-sided point of view by an "expert" has greater merit than that by another "expert". How do we combine such immense knowledge to take advantage of the diversity and make a better investment?

In this first part of the book we lay out the reasons for the urgency that exists for adopting and implementing group decisions and introduce and illustrate how the Analytic Hierarchy Process (AHP) can be used in making decisions. Chapter 1 describes the challenges of group decision making today. The complexity inherent in having groups manage various processes has been the subject of many years of research and the finding is that having a structured group process is key to success. The general impossibility of aggregating ordinal group judgments was formerly considered an obstacle to finding a structured method. But the AHP with its method for combining group judgments removes this obstacle. The Fundamental Scale of the AHP and its application are introduced using an example. Chapter 2 describes the step by step process of applying the AHP in more detail using an example of choosing the best hospice with many intangible benefits and costs. Several examples are given that validate the use of the Fundamental Scale in estimating different kinds of physical measurements. This scale both makes the AHP less taxing to apply and also makes it possible to combine group judgments scientifically to obtain fully justified representative judgments for the group that include the power and influence of its members.

# Chapter 1

# The Need for a Structured Approach

This book is about how to measure the intensity of people's feelings and judgments. Scholars and people in general once thought that you cannot construct a quantitative model that represents with reasonable accuracy how strongly a person reacts to influences. Going further, many people still believe that you cannot combine individual judgments into a representative judgment for a group. But in fact you can – and we will show this in detail throughout the book.

To decide is to choose the best course of action. To choose the best course for action calls for knowledge and sound judgments about what objectives are served by the action and how important they are among all the objectives that are served by all the decisions made and actions taken. It also calls for an understanding of what influences the decision's success and

what resistance the action might encounter that would frustrate fulfillment of the objectives. Moreover, it takes planning to determine the effects of the decision in the scheme of things. To judge the relative importance of objectives and influences and trade them off is the heart of decision making. Determining what is more important and what is less important – and how much more or less important – is a quantitative concern that calls for careful measurements. In fact judgment and number are intimately related. Is it possible to measure judgments in a scientific way that is sensible and easy so that we can use the outcome to make better decisions? Although we have been told over and over again that it is impossible to quantify how much more important one thing is than another, we need to find an easy way to link judgments and numbers by observing what people actually do in the real world and then find a suitable framework that we can all use without undue exertion.

The purpose of thinking about decision making is to help people make decisions according to their own understanding so that they feel they really made the decision themselves according to their own values, beliefs, and convictions. To make a good decision, people cannot simply rely on their feelings. They have to consider what it is they need to decide on, what influences their decision, and what alternative courses of action are available to them. They also need to think systematically about the impact of different influences on their decision. Finally, to make judgments they need to call on their past experience. Until today there has been no formal way to make a decision except to wait until there is the pressure of an emergency and then react to it impulsively taking the first option that comes to mind. To make use of thinking and judgment in decision making is what we need to learn more about.

This book is about making group decisions with clarity and confidence. It provides a systematic and workable way to make group decisions despite differences of opinion and disagreements. By making explicit a host of hidden assumptions, knowledge can be used in a rational way to prioritize the alternative outcomes of the decision in order to choose the best one among them. When several people who have varying knowledge, judgments, and expectations are involved in making a decision it is even more essential to have a defensible way to combine their knowledge using a single framework on which they all agree. Moreover there need to be ways to combine their different judgments into a collective judgment that takes into account the importance and reliability of each person's judgments. As we learn to make better decisions for a group, of

course, we also learn to make better decisions for ourselves as individuals. Making a good decision requires us to get under the hood and study the processes that run the decision-making engine.

The methods presented in this book are unlikely to be found anywhere else in the literature about group decision making. We base our approach on cardinal numbers that belong to an absolute scale. The numbers in an absolute scale cannot be transformed to other numbers like kilograms to pounds and meters to yards and mean the same thing. This way, they are said to be invariant under the identity transformation. A cardinal number is any number that expresses amount, as *one, two, three,* and so on, as distinct from an ordinal number which is a number indicating position or order in a series. People committed to the old ways of thinking find it especially hard to accept the idea that judgments have intensities that can be measured to yield priorities that are then used to make decisions. A.F. MacKay [1] writes that pursuing the cardinal approaches is like chasing what cannot be caught. Moreover, much of quantitative thinking in economics is based on utility theory, which is grounded in lotteries and wagers [2], thus implicitly subsuming benefits, opportunities, and costs within a single framework of risks. But lotteries are deeply rooted in the material exchange of money, and it does not make very much sense to exchange intangibles such as love and happiness with money. The real value of money varies among people and is a utility. Utilities are measured on interval scales like temperature. They cannot be added or multiplied and fall quite short of the kind of thinking people do to make a decision.

Of significance here is Kenneth Arrow's proof of the impossibility of combining individual judgments into a group judgment that satisfies certain conditions [3, 4, 5, 6] shown in Figure 1.1. His thinking was grounded in using ordinals to express preference in order to prove "impossibility." What does this mean? In the ordinal way we can say that A is preferred to B but not by how much. In other words, Arrow's logic follows the dictates of ordinary logic without the use of quantities to define people's preferences. People in academia have assumed that the impossibility of a group working together without making its members unhappy in some way is simply a logical fact. The real world, however, does not seem to work this way. All living things respond with different intensities to different influences. If A is a clear sunny day and B is a dark and gloomy day, we do not just say I prefer A to B, but I prefer A lots more than B. And we need to capture this

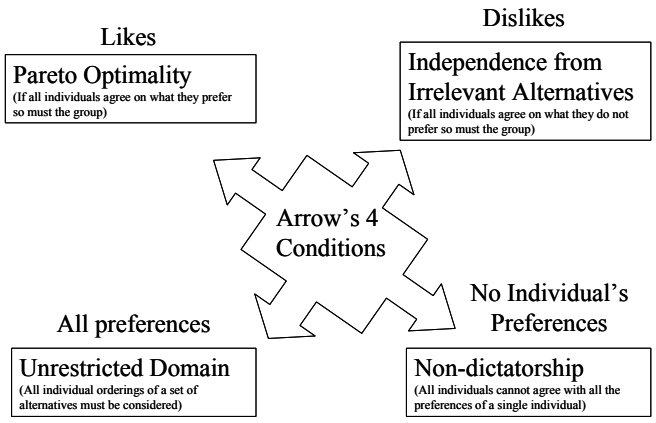


**Figure 1.1** Arrow's Four Conditions a Welfare Function Must Satisfy

distinction in our considerations. Readers interested in a proof of the possibility of group decision making that satisfies all of Arrow's conditions should read the last chapter of this book. It shows that we can indeed construct a group preference function in a practical way from individual preferences that satisfies conditions that Arrow's ordinal approach does not. Long after the AHP appeared in the early 1970s, some people perhaps unknowingly, proved the existence of such a cardinal approach without constructing one.

The social sciences have failed to find a way to quantify thinking because the logic we use today, often attributed to Aristotle, is inadequate to deal with the refinements required to handle the complexity of our world. We need a finer logic – one that not only uses words but also numbers and that can synthesize such numbers to show what should be the real output of our thinking and our responses to happenings in the world. Logical thinking as we know it today cannot do this.

The method presented in this book, the Analytic Hierarchy Process (AHP), has been developed over the past thirty years and applied many times by numerous corporations and governments [7, 8, 9]. It involves structuring a decision as a hierarchy whose upper levels are independent of the lower levels; providing pairwise-comparison judgments; deriving priorities from these judgments; and synthesizing the priorities to determine the best alternative for a decision. The AHP has been generalized to the

Analytic Network Process (ANP). In the ANP the decision structures are networks in which everything can potentially depend on everything else, including itself. There is software called DecisionLens that is very good for making decisions with hierarchies. See www.decisionlens.com. The software for network models is called SuperDecisions. Learn more about it at: www.superdecisions.com. Of particular interest in group decision making are radio frequency keypads such as the ResponseKey keypads which allow the members of a group to directly enter judgments on one computer. Each participant may respond to posted questions, express preferences or respond to test questions by selecting and pressing one of fifteen keys. The key presses are transmitted to a receiver connected to the computer via a nine-pin connector on the rear panel.

The AHP/ANP is based on making comparisons rather than just assigning numbers off the top of the head. Making comparisons is basically a scientific process that takes a pair of elements and asks how much the larger one dominates the smaller one with respect to a certain property. The two elements must be close so that we can say that one dominates the other by 2 or 3 or 5 or 9 times – but not more than that because there is a limit to our ability to compare the very small and the very large. If they are far apart, we will show a way of putting them into groups then using a common pivot element from one group to the next one to link the measurements of the elements in the groups.

**Making Comparisons – an Intrinsic Talent**

Cognitive psychologists know that making comparisons is an intrinsic human talent and everyone can do this whether educated or skilled or not. Comparisons can then be used to derive relative numbers representing importance or priority. In his book *The Process of Cognition* [10], the Harvard psychologist Arthur Blumenthal tells us that there are two types of judgment: "Comparative judgment, which is the identification of some relation between two stimuli both present to the observer, and absolute judgment, which involves the relation between a single stimulus and some information held in short term memory about some former comparison stimuli or about some previously experienced measurement scale with which the observer rates the single stimulus."

In his book *The Number Sense*: *How the Mind Creates Mathematics*, the mathematician and cognitive neuropsychologist Stanislas Dehaene [11] writes: "Introspection suggests that we can mentally represent the meaning

of numbers 1 through 9 with actual acuity. Indeed, these symbols seem equivalent to us. They all seem equally easy to work with, and we feel that we can add or compare any two digits in a small and fixed amount of time like a computer. In summary, the invention of numerical symbols should have freed us from the fuzziness of the quantitative representation of numbers."

In the past, people talked around intangibles and mostly decided to exclude them, from decision making because they are so subjective. Without measures for the intangibles, however, there is likely to be a lack of agreement on values among the parties in a conflict. While each party can reduce the trade-offs to a single best outcome according to its system of priorities, it is hard to trade off values among several parties because of their differing objectives. In this case we must find an abstract way to define an index for trade-offs among the parties that would be hard to reject on grounds of fairness. In this book, we propose a way to do that.

Comparisons lead to relative thinking and to relative numbers in the form of priorities. People up to now have tended to improvise numbers to capture order without regard to the validity of these numbers in practice. It turns out that relative numbers can be used to estimate all kinds of "objective" measurements that are converted to relative form by dividing by their sum. This is a rather surprising notion for scientists who believe that the truths of the natural world are independent of the human mind. The brain has its own structure that works in certain ways that are not absolute and without constraint. It uses electricity to create feelings, images, aesthetics, and all the things that make us human.

Decision making is a central activity of the human mind; we do it continuously both consciously and unconsciously. For instance, our body continuously and rapidly makes decisions that affect how our immune system will respond to foreign antibodies. Animals and plants are decision makers, too, each in their own way, as a matter of survival. Making better decisions improves our chances of survival and enhances our quality of life. If we know how to use information to make decisions with greater certainty, we can implement them with confidence. Decision making requires a modicum of creativity to develop a structure for the factors and the alternatives of a decision.

Individuals only have to agree with themselves to make a decision; groups, however, generally have trouble coming to a consensus. Therefore all progress in group decision making comes from group members being able to work together. For a good decision, the group needs to be diverse

and informed. Its members should hold independent judgments that are not coordinated in advance, to allow for a creative and lively discussion. Above all, the group needs a way to synthesize the judgments of its members into a representative group decision. Decisions can be normative, involving the most desirable outcome, or they can be descriptive, involving what is most likely to happen in view of all the influences at play. There are, of course, ongoing difficulties with decision making. An individual or a group may fail to tackle problems before they occur or fail to recognize them when they occur. They may choose the wrong solution to a problem, or they may make the right choice but it does not work out. Each of these challenges calls for its own kind of remedy.

Often a person must decide whether or not to do something. At other times a person must choose the best of several alternatives. The choice usually depends on many criteria: solving a problem, saving money, putting forth less effort, obtaining favorable influence on the people affected, and so on. Because the criteria may have different levels of importance, we need to establish priorities for discriminating among them. Our approach involves three steps. Step 1: Lay out all the factors of a decision and their interconnections in a hierarchy or network of influences. Step 2: Provide judgments in the form of pairwise comparisons to determine what dominates what and how strongly. Every factor that needs to be considered must be included, and every piece of information must be articulated. Step 3: Synthesize all the judgments about the alternatives and then choose the alternative with the highest priority. When there are resources to allot to a number of alternatives, the allocation must be made according to the priorities.

We live in a world of increasing complexity and accelerating change that forces us to keep learning just to get by. Complexity requires training to cope with it with the emphasis on creative decision making rather than merely following old habits. Technology is the major driver of change today; it speeds things up and increases communication – breaking down the world's boundaries. Technology is intensifying the global economy and sharpening competition, both on the personal and organizational levels. Well-thought-out decisions, especially those involving other people, spell the difference between success and failure.

Although complexity and uncertainty bring challenges, they also bring opportunities and create more possibilities. Technology may make some of our skills obsolete, but it also opens up new ways for us to do more meaningful and productive work. Information technology may cause us to

feel overwhelmed with data, but it also enables people thousands of miles apart to work together. Complexity and change make the future less predictable, but they also offer a competitive advantage to those who know how to anticipate situations and impose structure on what seems unmanageable. These challenges may make us feel less competent as individuals, but technology facilitates collective effort. The key is to work with others in striving for common objectives that take into account the aspirations of every member of the group.

In a stable environment, learning means remembering past experiences and finding new ways to make better decisions as similar situations arise. But can we safely assume that a solution which worked in the past will work in the new situation? Complexity and uncertainty mean that the environment is dynamic – that is, no situation can be assumed to be exactly the same as in the past. Moreover, we cannot assume that an old solution will work when applied to a somewhat similar situation. A dynamic environment adds a new perspective to learning because it is less about acquiring new knowledge and more about knowing how to deepen our understanding and awareness of the assumptions underlying a problem. Working with a group can help with this. If the people know the subject they are trying to make a decision about, their knowledge and expertise will enrich the group's awareness.

**Why Use a Structured Approach?**

Let us look at the reasons why we need a structured approach for group decision making. First decision making is contextual. A decision depends on the environment, the objectives, the people who make the decision, and related decisions and problems. These factors must all be considered when making a decision. We may think the outside world is the only source of complexity, but this is not the case. There are internal complexities that can affect a decision and must be considered as well.

Second, we make decisions to satisfy our needs and promote our values. As social beings, we get value from what we do and what those around us do. If we belong to an organization, we increase our personal value indirectly by working with others to increase the organization's value. Working together with people calls for reconciliation of individual and group values with those of the organization.

And third, we need to heighten awareness to make decisions in a complex environment. We can no longer expect to make good strategic

decisions in a casual or intuitive way. Complexity is what we find in most of our decisions; and it derives from both internal and external influences on the organization. Complexity can also be traced to the interdependence of the different decisions that people are making in an organization. Now let us turn to the various types of complexity that stem from different sources.

**External Complexity**

There are at least three different sources of external complexity. In the first case, not only are there different parties with different values who influence the outcome of a decision and its implementation, but there also are other parties who may not have the power to decide but are nonetheless important stakeholders whose interests must be considered. The second source of complexity comes from how different events are linked to each other. The events may be interconnected in such a way that it is hard separate the cause (the source of an influence) from the effect. Several events together may cause more than one effect. In some situations there is a long delay between the cause and its effect, or the effect may be experienced by people other than the decision makers. The third source of complexity comes from the discontinuous trend of change over time that makes it so hard to predict the future.

Experience suggests that limiting decision making to the top of the hierarchy is one of the reasons why strategic plans go unimplemented [12]. Organizations do not work like mechanical entities that can be programmed to perform according to predetermined standards. Members who are lower in the hierarchy have brains, too, not simply mechanical muscle. More than ever, people do not merely exist in their world but also participate in creating it. As a product of our thinking, this world cannot be changed without changing our thinking. People need to be given decision-making roles; they may even determine the success or failure of the organization. Involving the right people in a decision may not always be easy but using their knowledge to deal with a complex problem is absolutely essential.

New concepts of leadership are emerging today in successful companies that are fundamentally different from companies that have seen success coming from people at the top with somewhat superhuman characteristics. Research has discovered that today's successful leaders are those who make use of their people's talents. If you study companies that had a high level of growth for fifteen consecutive years, you will find that their leaders have not only a powerful commitment to achieve results but

also the skill to bring out the best in subordinates. These leaders set high standards for results – and then share credit for good results and the success of the company. And when failure happens, they take responsibility rather than placing blame elsewhere [13]. Good leaders have high levels of executive intelligence in three dimensions: they seek to excel in their job; they work with and through other people; and they are involved in self-learning [14]. Surely an organization can use many such leaders, not just the one at the top.

**Internal Complexity**

Daniel Kahneman of Princeton University won the 2002 Nobel Prize in Economics for his groundbreaking research concerning the pathological mistakes and persistent miscalculations made by intelligent people in decision making [15]. He observed that people continue to make irrational choices despite having adequate information. In an automatic, almost unconscious, way we often use intuition alone to respond quickly to the world. This kind of behavior is difficult to control and is often emotionally charged. By contrast, reasoning one's way through a decision is a conscious and deliberate way of thinking that often follows rules but takes a great deal more time. Kahneman also noted that organizations make many decisions but do not go back and try to actually understand what they did wrong. He concluded that organizations simply do not care to know. Even when people admit they have made a mistake, it does not mean they have changed their mind and would be able to avoid the same mistake in the future.

The mind is limited in its ability to handle many items of information and the relationships linking those items at any instant. An item may be a word, an idea, or an object in a scene or a group of items called a chunk. George A. Miller [16] has shown that the magic number of items of information the brain can handle at one time is seven plus or minus two. Like a computer, the human mind takes in information, performs operations on it to change its form and content, stores and locates it, and generates responses to it. Thus processing involves gathering and representing information or encoding it; holding information or retaining it; and getting the information when needed or retrieving it. It is reported that working memory sometimes contains over twenty units at one time.

People do not seem to have much control over what information gets stored in their memory. Items in working memory decay over time. The longer it has been since an item was stored, the less likely it is to be

currently available; this is why people tend to forget things. The probability of remembering is a function of how many times the information enters the mind, so that articulation, hearing or seeing the item in writing, increases its availability. Losing information from the mind may be a good thing for our mental health – helping us to forget bad memories – but a degree of effort is required to ensure that wanted information is stored and stays in memory. What we need, then, is a decision support system that records the history of a decision with adequate detail.

Classifying and grouping things into chunks is a well-known psychological phenomenon of memory; indeed it is one of the most primitive and common activities of human beings. The limited capacity of the human mind is in a way a blessing because structuring becomes a natural process of organizing the enormous number of information items into chunks, which helps information processing. Grouping things into information chunks enables us to think within the limits of our working memory. Even in nonlinear relations, people naturally build connections between what they have just processed and what they currently are processing and, ultimately, what they expect to process in the near future. Structuring information items into a hierarchy or a network makes this process efficient.

The mind does not work in a seamless continuous way. Rather, the mind is aimless and disconnected. Even when it focuses, the mind is unable to retrieve from its memory storehouse all the information needed. Often the ideas only come to mind later and are added to current information in a patchwork fashion. People, moreover, are forgetful; they remember now but then later behave as if they did not remember. Just as we use language to organize the thoughts behind feelings, we need a systematic way to collect the factors that have bearing on a decision and organize them into a dictionary for easy reference. This systematic approach also would provide a framework for judgments and discussion, helping us to avoid random thoughts and wandering off the subject.

The working memory of experts is no better than that of everyday people. But because of many years of experience, experts have larger and more complex memory chunks. These chunks make it easier for them to recognize complex patterns quickly. Further, they are able to develop commonsense rules to help them solve problems efficiently. The quality of their intuitive decisions is questionable, however, because each decision needs to be thought out carefully due to changing circumstances. The world does not stand still to allow experts to bring their experience to bear on decisions of the future.

We all have mental models of our perceptions and assumptions about the world; they guide our actions and help us in dealing with the world [17]. Such models, however, are inherently subjective and biased toward the past; hence they may not always work in a collective context. Some models may even lose their effectiveness as changes in the environment demand different actions. Aligning the mental models of group members is considered to be one of the key processes in learning organizations [18].

**The Problem of Interdependence**

One aspect of decision making is consistently underestimated: interdependence. A decision generally does not stand alone. It is usually related to other decisions or is part of a higher-level decision. A business strategy depends on the overall corporate strategy, for instance, while a new product strategy depends on the relative importance of technology in the target market. IBM's Silverlake project is an example of interdependent decision making using the AHP [19]. In Chapter 4 we show an example of successive strategic decisions using AHP – from product and competitor analysis to strategy selection to prioritizing strategic initiatives in order to implement the strategy.

**The Need to Sharpen Purpose**

What makes decision making largely subjective is that it is driven by the needs and values of the decision makers. This is as true for personal decision making as it is for a group of executives who want to satisfy the needs and values of different units in their organization in a collective decision-making process. Reconciling the needs and values of individuals in a group with those of the organization's makes group decision making especially challenging.

Abraham Maslow [20] classifies seven basic human needs in order of importance from most basic to least basic:

1. Homeostatic (physiological) needs
2. Safety and security needs
3. Love and belonging needs
4. Esteem needs
5. Self actualization needs

6. The need to know and understand
7. Aesthetic needs

There is overlap from need to need. Each successive need emerges little by little as the previous need is partially satisfied. A need may be 25 percent satisfied when the next one emerges 5 percent. If the previous need is 75 percent satisfied, the following need may emerge 50 percent. Nicholas Rescher [21] argues that people's values guide their deliberations and help us to understand their decisions and actions. A thing has value when it is the object of interest – any interest. Values like the following are related to actions in categorically different ways:

- A motive, habit, or disposition for action (bravery, generosity)
- A physical state (health, good looks)
- A capability, skill, or talent (agility, endurance)
- A state of mind or attitude (indifference toward money, patriotism)
- A character trait (resoluteness)
- A state of affairs (privacy, economic justice)

Within a group, individuals do not give up their personal values but may be willing to trade some of their personal needs and values for certain group values:

- Physical (health, exercise, sports)
- Educational (learning, communication, information)

- Economic (money, property)
- Social (welfare, cooperation, organization)
- Political (power, influence)
- Moral (order, honesty, trust)
- Ideological (religion, common belief, fervor)
- Technological (innovation, change, problem solving)
- Military (security, force, defense)
- Aesthetic (art, music, theater)
- Competition ( quality, reasonable pricing)
- Negotiation (give and take)
- Conflict resolution (reconciliation)

Defining complex problems requires a high level of understanding and needs to be part of the decision-making process. Often it is harder to define a specific problem than it is to decide what to do about it, and it is the decision maker's responsibility to ensure that the decision is consistent with the definition of the problem. Decision making is about finding the question that focuses thinking on understanding the problem; after all, it is useless to find the right answer to the wrong question. Brainstorming techniques to generate questions, rather than the usual preoccupation with generating ideas, have often been used by groups working on complex problems.

A good understanding of a problem and its context is likely to lead to a good decision. Since understanding is inherently tacit, it is essential to articulate the problem carefully in group decision making. Even here a team may only be able to frame the description generally and be forced to leave much of the knowledge tacit in its members' minds. Well-defined problems, as in science, are those that come with well-established ways – or algorithms – for arriving at correct solutions. These problems are manageable because we work within certain boundaries that place limits on the scope of the problem. (This is not to say that such problems are easy to solve.) Complex problems, by contrast, have no known algorithms to solve them because their boundaries are ambiguous and difficult to define. Because we need a boundary if we are to design a solution effectively, we are compelled to define the boundary ourselves. Defining and structuring a decision problem must include all the important goals, objectives, factors, actors, and stakeholders; alternative courses of action must be fully represented; benefits, costs, opportunities and risks must be fully considered.

**Two Kinds of Purpose**

Influences and values are two basic considerations in decision making. While people do not usually surrender their personal values, they may be willing to trade off some of their lower-level needs listed by Maslow for higher ones. Group decision making is a way to address some of the higher-level needs, such as the sense of love and belonging that comes from being a member of a solid and well-performing group. Members who feel they contribute a lot in producing decisions that lead to group success would certainly feel that their self-esteem and self-actualization needs also are satisfied. There is no sense of belonging or self-actualization to be found in a group decision-making process led by a dictator.

One goal of decision making is to find opportunities and courses of action that realize an organization's objectives – a proactive goal. But sometimes the goal in decision making is reactive – solving problems of deteriorating performance, for example, or dealing with threatening events. Research suggests that setting group goals is one of the foundations of successful teamwork. The goal is not only the focus of the group decision-making process but also the reference for evaluating alternative courses of action. The goal must be relevant to the higher-level purpose of the organization. Breaking down an organization's purpose into lower-level objectives ensures that they can be more easily made relevant through implementation.

Balanced Scorecards, as described by Kaplan and Norton in their series of books [22, 23, 24], have had widespread use as a systematic process for translating an organization's strategy into actions. They serve as a roadmap by breaking down the organization's purpose into clear and specific objectives. The prioritization process enables an organization to allocate resources to different efforts. Mobilizing members toward a set of the organization's strategic objectives calls for aligned actions, and prioritization directs this effort accordingly to ensure more effective and efficient endeavors.

Group decision making does not mean that consensus is always reached. Nor does it mean that all team members have to be involved in every aspect of a decision. Team members are expected to process data and apply their individual expertise to contribute to the outcome. Members also are expected to communicate relevant information and recommendations. If the final authority for a decision rests with a single person, the team members provide the decision maker with assessments that are crucial to the situation. Otherwise how would the decision maker be able to process all the information single-handedly?

Group decision making is a process that requires the participation of every member. Often a group task calls for the application of expertise beyond that of a single person. Individual competence is necessary but not sufficient because accomplishing a group task is not simply a matter of coming up with a decision. The group also needs to work on enhancing its cohesiveness because the quality of its decisions depends on the ability of its members to function collectively as a coherent unit. The group decision-making process needs to bring satisfaction to its members by achieving the task and creating desire to participate in future sessions. In a way, each

group session is an investment in developing a long-term collaborative climate.

By involving people with different views, collective decision making widens the perspective of individual decision makers. The challenge of group decision making is how to integrate all the different mental models and diverse perceptions. Moreover, involving other people in decision making creates a new complication because psychological issues of group interaction come into play. Apart from coming up with a decision – called the achievement or content goal – the group also needs to work on preserving good relationships between group members – the maintenance goal. Since these two goals are intertwined, a group leader must simultaneously manage both processes, which means choosing a way to deal with the decision that serves both goals. The structured approach we describe in this book has been used successfully by consultants to facilitate group decision making in complex situations.

When we hear the word "conflict," we may regard it as a negative consequence of group decision making. Often a group is so divided and chaotic that it is a hellish job to bring members together. But conflict can be a productive process, too, because it indicates a diversity of ideas. Research has shown that although managers understand the logic of conflict, they are uncomfortable with the emotional component. Conflicts that keep members focused on relevant differences of opinion tend to improve the team's effectiveness.

Research also shows that the more intense the conflict, the greater the degree of formality needed to manage it. The conflict management method proposed in this book enables a group to approach a decision with an open mind while minimizing conflict-triggering behavior. As ideas become less personalized, egos are less likely to be challenged and the need for time-consuming and distracting conflict management is minimized.

**Alignment: The Key to Effective Decision Making**

Problem solving is concerned with maintaining the status quo so that performance does not deteriorate. The key process here is finding the cause of deviation from the standard. When we know the cause, action can follow. Problem solving is often associated with finding the right answer – that is, finding the real cause of the problem. Finding the right answer focuses thinking on looking for the best action to bring performance back to normal.

Consider, for example, the actions taken to solve quality problems in a complex manufacturing environment. Based on the degree of involvement of people in different management levels [25], the "total quality" movement initiated by Japanese manufacturers makes a distinction between the processes of maintaining standards, making continuous but incremental improvements in the workplace, and innovation. Maintaining standards is mostly in the hands of the shop floor workers who work in teams to solve operational problems. Continuous incremental improvement involves all management levels. Innovation is mostly top management's responsibility.

"Problem solving" may not even be an appropriate phrase for the process of finding an answer to a complex problem, since a complex problem can hardly ever be "solved." Solving it is more a matter of designing a solution (a stream of well-connected or coherent decisions) that we think will be more or less effective, based on how the problem is defined, than of finding an answer that is definite and final. Decision makers need to describe the problem – and the quality of their decision will depend on how well it is defined and how the goal is stated.

**Organizational Alignment**

In a world of fast change and increasing complexity, organizational decision making is the privilege of those who have the relevant information. A study released by the 3M Meeting Management Institute indicates that people who have the most knowledge about an issue may exert greater influence on decisions than those who have the most power. Clearly, then, an organization will benefit from a system for sharing knowledge among its members.

Some complain that group decision making takes too much time. The 3M Meeting Management Institute says that employees spend about one and a half hours a day in meetings – most of which are called with a 2 hours' notice, and less than half of which have an agenda. It has been reported that a typical meeting of six mid-level managers can cost an organization around $2,000, and this money is often wasted due to poor results or no results at all. Romano and Nunamaker report: "Studies of managers and knowledge workers reveals that they spend between 25%-80% of their time in meetings. Estimates of meeting expenses range from costs of $30 million to over $100 million per year to losses between $54 million and $3.7 billion annually. Self estimates of meeting productivity by managers in many different functional areas range from 33%-47% " [26].

The work of R.M. Belbin [27, 28] is perhaps the most significant piece of research on team effectiveness undertaken so far. His result does not support the common belief that you bring the most intelligent people together, you inevitably get a high-performance team. He discovered that the role people play in a group process is more important than their technical ability in determining the team's success. According to Belbin, there are nine ideal roles that contribute to effective group decision making.

- The *Coordinator* controls team progress toward its objective by making use of the team's strengths and potentials.
- The *Shaper* shapes the group process in an authoritative way with a sense of urgency.
- Creative ideas would come from the *Plant*, who offers new ideas and recommends strategies to solve the problem.
- The *Resource Investigator* with an external network looks for resources or help from outside the group.
- The *Team Worker* improves communication among team members and maintains group spirit.
- The *Monitor-Evaluator* analyzes the problem by evaluating inputs from group members and ensures a balanced decision.
- The *Implementer* translates concepts and plans into practical work procedures and implements the plan systematically and efficiently.
- The *Completer-Finisher* protects the group from making mistakes, looks for things that need special attention and maintains the sense of urgency.
- The *Specialist* shares knowledge and gives professional advice.

Belbin suggests that a group should have a diversity of team roles. It may be easy to establish a group comprised of people who have good understanding, but these people may not be able to use that considerable understanding to reach a good decision. Experts often lack the skill to encourage mutual participation – and therefore fail to elicit the most relevant information that has a bearing on solving the problem collectively in a smooth way by maintaining the high spirit of teamwork. In this book we present a method that helps elicit and organize and utilize collective knowledge. The group decision process we describe helps us refine our initial judgments and determine how stable the outcome is likely to be if the judgments were to change dramatically. With group diversity, a compatibility measure is provided to identify nonhomogeneity in thinking

that needs special attention since it may indicate a better perspective. If used by knowledgeable people, this method produces very accurate outcomes.

**Forward and Backward Planning**

Knowledge and information are usually about the past, which may or may not be useful for looking into the future. Extrapolating past and present trends into the future, as in statistical forecasting, is of little use in a world with rapid change and discontinuous events. It ignores the possibility of a unique event that could alter the pattern of the extrapolation curve. Since the task of management is to create the future, personal perception is more appropriate for making strategic decisions, but we need to balance perception with analysis. The future is better seen as the result of today's actions by all the people involved, rather than an extrapolation of past and present trends.

Doing nothing is also a decision. It is then incumbent on us to know what the consequences of doing nothing might be. At the same time, a decision must be evaluated in terms of making a difference compared with doing nothing. One way to do this is to project where we would be by doing nothing, compare it with where we would like to be, and then determine what we must do if the gap between them is not to our liking. Clearly we need to do something to bridge the gap. It is essential that we do both: plan forward to predict what would happen if we do nothing, and plan backward to design a strategy to create the kind of future we want [29]. Perceiving the future as the result of past and present decisions, then predicting the consequences of doing nothing, implies that other people will keep doing what they have always done. But other people will in fact pursue their own desired future, just as we do, and it is fair to assume that they will react to any of our strategies that would hinder the achievement of their objectives, including our doing nothing. Since we cannot ask them what they would do, we can only predict their future actions in yet another backward process representing their interests.

Basically we must ask the following question: If we were in their position, what would we do in response to our strategy? With this hypothetical information, we now need to repeat our forward planning to see how the decisions of others would shape the future. This process leads to viewing strategic planning as an iteration of forward and backward processes. And if we find that the set of backward planning iterations to arrive at a desired future are not really independent, we will need to capture

their interactions. This emphasizes, even more, the need for members of the organization to do it themselves. The learning gained from the process will be valuable in implementing the plan. While the process may be carried out as a formal planning process at a designated time, it must be updated regularly to account for the incremental adjustments necessary to keep up with events. To do this effectively, an organization needs a set of records – records that represent its memory of what has been done as well as all the processes that led to the decisions. Essentially, the set of records needs to function as a work-in-progress that can be modified easily.

**Advantages of Structured Decision Making**

Collective decision making is a necessity. Not only is there a need for diverse perspectives, but gaining the acceptance of those who must implement the decision is as important as making the right decision. To get acceptance means that the psychological problems of working together must be dealt with. Further, in making a decision there are often as many intangible as there are tangible factors, and we need a decision calculus that can handle intangibles simply. What we need is a valid method for eliciting and structuring information from group members in a natural but organized way in order to produce a synthesis. The approach should be scientific but user-friendly.

After an intensive study summarizing more than twenty years of research on teamwork, Dennis A. Romig concluded that "the more systematic or structured the teamwork component was, the better the team's performance" and "the most successful structured approach includes defining the problem clearly" [30]. His first conclusion highlights the systematic process team members use to work together on making a decision; the second highlights the fact that they use a model to capture their understanding of a problem.

**Using a Model**

The word "model" means different things depending on the context. In decision making, a model means a representation of reality with the intention of gaining understanding about it. A model is a useful way to describe a complex reality that is beyond one's mental ability to comprehend in every conceivable detail. A model is always a simplification. Even so, a model helps us obtain better estimates of reality by channeling our

impressions, feelings, and beliefs in a systematic way. Once we have the situation modeled, we can use the model to make judgments on the elements we have agreed on. The goal is to enhance objectivity and downplay subjectivity.

The intention of constructing a model is to capture reality so that one can design a solution that works in the real world. The key question here: how good is the model as a representation? No matter how sophisticated the method and how rigorous the process, it only captures the perception of those who use it. Moreover, simplification in modeling means that its outcome is at best only an approximation. How can we capture a wider perception so that the resulting model is a collective representation of group perception?

Although we have the ability to perceive complexity, it is difficult to communicate our perception using the same language we use in general conversation. Language alone is not enough for communicating a complex problem because it is ambiguous and the same word has different meaning for different people. We need a different kind of language for communicating complexity clearly. We need a language that facilitates articulation of our thinking and offers a productive framework to improve understanding. Above all, the right language can help us synthesize the diversity into a unified outcome to which everyone subscribes. By using a structure, we can relate many things to many others and express the relative strength of influences in the structure that when synthesized give a very accurate idea of what is likely to happen. The totality of judgments has a synergy that is lacking in individual judgments.

In developing a model there is always a trade-off. A model is a simplification of reality, certain details are inevitably excluded. The question is what to include and what to exclude. If key components are excluded, there is a chance that the model will be too simple and fail to contribute to understanding. But if too much detail is included, the model may become so complicated that, again, it fails to reach the deeper levels of understanding that we seek.

Apart from complementing the mind to manipulate numbers, the computer is useful for organizing information in a complex problem. In a group setting, the computer becomes a tool for collaboration. In modeling a structured decision problem, there is no limit on the information that a computer can process, but it is reasonable to expect that a user would process only between five and nine chunks of information at a time. To group small numbers of elements together improves the structure and

enhances understanding. It also results in a neater display on a computer screen to facilitate group interaction.

Without the aid of a decision-making model for systematically structuring a problem, decisions are often made intuitively. A group of executives learned this lesson when they worked on a problem using different approaches. First they were asked to find a solution via the usual group discussion. Then they were introduced to the AHP for a systematic approach along with some brainstorming and synectics [31] to generate alternative courses of action. They were surprised to find that the solution they had agreed on via the traditional discussion process came out as the worst.

A decision-making method with computer support is invaluable. It is mostly useful with group decision making, where a lot of information needs to be organized. People tend to have trouble seeing the big picture and looking at the problem from different perspectives. A model, however, synthesizes all the different perspectives in a comprehensive yet clear framework.

It is useful to consider the way a model is constructed as a special language for describing complexity. As a language, it is a means to articulate a person's mental model in order to be understood by others. When we construct a model, the aim is to represent reality; but the best a model can do is represent the mental model of its developer. The way to construct a model that is a closer representation of reality is by inviting diverse perspectives from other people and integrating them into a single model. Having a good modeling language helps a group construct a collective model.

What we refer to as reality is simply our description of what we perceive. It is actually a simplified version of a "true" reality, of course, because of the screening and filtering process that takes place in the mind. Our very perception is a mental model itself: subjective and tacit, not clearly and precisely articulated. Constructing a model makes a tacit understanding explicit, but subjectivity remains. Four steps are involved using a decision methodology: structuring the problem by using a hierarchy or network; deriving priorities from the judgments; checking the results for logical consistency; and performing sensitivity analysis to ensure the stability of the outcome to changes in judgments. These steps become the principles that underpin the AHP decision method described in this book.

At this point an important question arises: Does the method produce an outcome that is useful? To answer this question we need to answer two more specific questions. The first is: What is the standard we are going to

compare the result with? In general, there is no standard for judging whether or not we have arrived at a good decision. Otherwise we would simply use the standard instead of going to all the trouble of striving for the best decision we can possibly make. In this case, the best thing we can do is to build confidence in the method by testing its power of prediction in a host of situations. These applications not only serve to validate the method but also emphasize the need to have credible decision makers and experts to come to a close approximation. Once we have confidence in the method, we simply need to make sure that all important elements of a decision are considered.

The second question is: What is the maximum deviation from the standard that will allow us to say that two outcomes are close? This question may seem as irrelevant because we do not have standards. Nevertheless, it is a useful question in the context of group decision making to assess the diversity of group judgments. The AHP/ANP has a concept – measuring the compatibility of two ratio scales – that is useful for evaluating how close individual judgments are to those of the group.

**Creating a Structure**

We have the ability to perceive things and generate ideas. Our minds structure complex reality into its constituent parts, then their subparts, and so on hierarchically. If some feedback or dependence is perceived, it can be structured as a network. By breaking down the description of a situation into homogeneous clusters (with five to nine elements in each cluster), the human mind can integrate large amounts of information to form a picture of the entire system.

A typical decision problem requires us to choose the best among several alternatives with respect to a set of criteria. Take, for example, the problem of selecting the house that gives us the most satisfaction. We have six criteria and three alternatives. Unless we simply jump to a conclusion intuitively, this could be a taxing problem. With the method advocated here, however, it is a simple decision. Figure 1.2 is our house selection model.

The hierarchy is constructed from the top down. The best choice is made on the basis of the criteria at the top, which may be thought of as representing the forces acting to shape the possible outcomes. The object is, given the goals and values, to find the best alternative with the given criteria that represent the decision maker's values. To do this, we distribute the forces downward from the most general to the most particular. Values

precede the alternatives in importance. We determine the relative strength of each alternative in satisfying the criteria.

In this problem the decision maker considers only criteria relating to benefits – implying either that cost is not a decisive factor or that the difference in cost among the houses is considered insignificant. The problem would be more complex if costs need to be considered as well. We might intuitively argue that costs are not comparable with benefits. In this case, we would want to represent them in a separate hierarchy with a set of criteria representing costs and other pains, such as purchase cost and maintenance requirements, but with the same alternative houses: A, B, and C. Depending on how the decision maker relates benefits and costs, the two hierarchies may or may not be aggregated into one larger hierarchy with benefits and costs as the two main criteria, each with its own subcriteria. As we will make clear later, with examples, that decision makers can relate benefit and cost considerations in several ways and also include opportunities and risks.

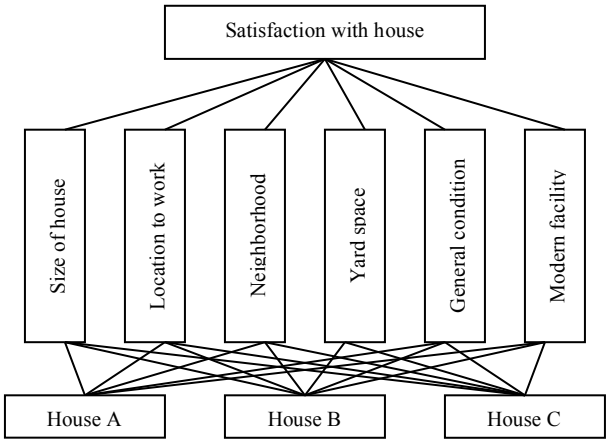


**Figure 1.2** Simple Hierarchy for Selecting a House

**Dominance and the Scale of Comparisons**

Decision making is essentially arriving at a judgment on your preference for one alternative over another. We may say that the preferred alternative "dominates" the less preferred one. Consider this simple example: A person is given a choice of an apple or an orange to eat. Say that he picks the apple, which means that he regards the apple as dominating the orange in his mind. Then suppose that, given the same choices next time, he takes the

orange instead. What happened? Is he being inconsistent? It appears he is not. Instead, his explanation illustrates the contextual nature of a decision. He might say that in the first situation he took the apple because he was hungry and he thought that an apple would satisfy him more than an orange. In the latter situation he was thirsty and took the orange because it was juicier than the apple. He made the decision by considering the relative importance of the properties of the fruit with respect to his need. Assuming that he maintains his relative preference between apple and orange with respect to substance and juiciness, it is the change of their relative importance that alters the decision. Structuring this problem like the one for selecting a house in Figure 1.1, we would have a simple multicriteria hierarchy: satisfaction with fruit as the goal at the top; the two criteria of substance and juiciness in the middle level, and the alternatives of apple and orange at the bottom.

When the articulation of judgments about relative dominance is reasonable and accurate, and the calculations are credible, we should get the same outcome from the model as the actual decision. Our fruit selection example indicates that we need to quantify not only the judgments of relative importance of substance and juiciness with respect to satisfying the physical need, but also the relative preference of apple and orange with respect to substance and juiciness. We may assume here that the relative preferences between apple and orange with respect to substance and juiciness are the same for both situations. But how are we going to represent the comparison judgments when we do not have any physical scales? Furthermore, how can we be sure that our model has represented the problem in terms of structure and priorities with reasonable accuracy? What feedback can be used to indicate the need for improvement? How can we make such improvements efficiently? In collective decision making, how can we aggregate group judgments in a credible and meaningful way?

Many people think that measurement demands a physical scale with a zero and a unit of measure. This is not true. In the AHP we use relative scales that do not have a zero or a unit and we get them by using our understanding and judgments – which are, after all, the fundamental determinants of what the measurements mean. We interpret readings from physical scales all the time without thinking about it. Physical scales are useful to have for things we know how to measure. But even after we obtain readings from a physical scale, they still need to be interpreted. And the number of things we do not have scales for is infinitely larger than the things we know how to measure.

The AHP/ANP uses a scale with absolute numbers from 1-9 called the Fundamental Scale, to express pairwise-comparison judgments. If we were to use judgments instead of ratios, we would estimate the ratios as numbers using the Fundamental Scale shown in Table 1.1. A judgment is made on a pair of elements with respect to a property they have in common. The smaller element is considered to be the unit, and we estimate how many times more important, preferable, or likely – more generally "dominant" – the larger is using a number from the Fundamental Scale. Dominance is often interpreted as importance when comparing the criteria and as preference when comparing the alternatives with respect to the criteria. Dominance can also be interpreted as likelihood – as in the likelihood of a person getting elected president – or other terms that fit the situation.

Using a universal measurement scale implies that people's perception is linear and homogeneous. But the real world and our perception of it are nonlinear and not homogeneous. Scales are simply indicators of quantity, and it is deceptive to think there is direct meaning in quantity. People need to interpret what a certain quantity on a scale means to them. We can capture meaning via judgments made precise through numbers, and the only way to do this is through comparisons with respect to a common property or goal. Scales of measurement have no intrinsic meaning in themselves.

Moreover, there are many people in the world who know very little about numbers and the arithmetic of numbers. Nevertheless, their judgments lead them to make good decisions with the feelings and understanding they have. It is not the manipulation of quantity but the synthesis of piecemeal understanding of influences that leads them to make good decisions. Quality itself is interpreted according to its effects and not according to some precise numerical value on a linear scale. This observation about the untutored mind is important. People derive meaning from broad and closely connected experiences that they combine to form their overall understanding, not from readings they observe on instruments of measurement. In the house selection example, the criteria are ranked according to their relative importance to satisfying the overall goal: satisfaction with a house. The relative priority of the criteria is not influenced by the alternatives being evaluated. Judgments regarding the houses will be about preference – that is, which house is preferred with respect to a certain criterion.

**Table 1.1** The Fundamental Scale of Absolute Numbers

| Intensity of Importance | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two activities contribute equally to the objective |
| 3 | Moderate importance | Experience and judgment slightly favor one activity over another |
| 5 | Strong importance | Experience and judgment strongly favor one activity over another |
| 7 | Very strong importance | An activity is favored very strongly over another; its dominance is demonstrated in practice |
| 9 | Extreme importance | The evidence favoring one activity over another is of the highest possible order of affirmation |
| 2,4,6,8 | For compromise between the preceding values | Sometimes we need to interpolate a compromise judgment numerically because there is no good word to describe it |
| Reciprocals | If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i* | A comparison mandated by choosing the smaller element as the unit in order to estimate the larger one as a multiple of that unit |
| Rationals | Ratios arising from the scale | If consistency is to be forced by obtaining *n* numerical values to span the matrix |
| 1.1-1.9 | For tied activities | When elements are nearly indistinguishable; moderate is 1.3 and extreme is 1.9 |

The process of synthesizing judgments involves numbers. Decision making, however, involves comparing intangibles for which no scale is available. Moreover, judgments about intangibles are expressed more naturally in everyday language than in quantitative terms. Hence using the verbal explanation from the Fundamental Scale that discriminates between our feelings is especially useful because its values have some kind of familiarity and help us to make the correspondence between our qualitative judgments and these absolute numbers of the scale.

People often say that a person is inconsistent if he changes his mind – illustrated here by the example of selecting fruit. This kind of change in preference is a consequence of a shift in context, however, which is different from being inconsistent. We have the ability to establish coherent relationships among objects or ideas – that is, to relate them to each other so that their relation exhibits consistency. Given three different geometric shapes to compare with respect to area, a circle, a square, and a triangle, if

we judge the circle to have approximately five times the area of the square, and the square twice that of the triangle, then the area of the circle must be ten times that of the triangle. This would be consistent. But the human mind does not work as precisely as an objective scale. Even a consistent person may not judge the circle to be exactly ten times the triangle. Judging the circle to be seven or eight times the area of the triangle may be considered acceptably consistent, however, while judging it as only three times the area would show great inconsistency, indicating that the comparison process would need to be repeated for more accuracy.

The mind that estimates the relative size of physical objects is the same as the one that compares intangibles. This suggests that there is an underlying scale that operates in the mind which we can also use in a decision theory. The Fundamental Scale needs to be validated to ensure its usefulness. If we have a way of measuring inconsistency, we can use it to find out the decision maker's consistency level – and the judgment that fits least well and contributes most to the consistency – and revise it to ensure a valid outcome.

Our inconsistency in making judgments may appear to set a limit on how many things we should deal with. Most decision theories disregard this phenomenon and even forbid it as unnatural. Yet inconsistency has not only been proved to be inherent in how the mind works but is a necessary capability of the mind to enable learning and growth. The mind has a screening mechanism to select only meaningful information from the environment. This screening process helps us to be effective by putting all the relevant information before us. Being able to be inconsistent is fundamental in developing our perception as it enables the mind to take in information that does not seem to bear full relevance to the issue we are thinking about at the time. But it leads to inconsistent judgments that may make a decision less reliable. The ability to measure the degree of consistency in our judgments is as critical as the development of a valid scale. Our maxim is: It is better to be approximately right than precisely wrong. Our method strives for validity and accuracy as checked against observable phenomena; it is not satisfied with a decision that comes up with a formally logical and precise outcome that has no relation to what is observed. In the following section we explain how a group of people working together on a decision can deal with judgments and their inconsistency.

**Creating a Synthesis of Group Judgments**

Group decision making takes advantage of the plurality of its members. The process needs to be managed, however, because decision making is about striving for agreement [32]. Disputes may arise regarding values, beliefs about the consequences of a decision, and preferences for certain alternatives. We need to capture as much diversity of thinking as possible and to process agreement and disagreement in a systematic, efficient, and credible way. The more disagreement can be tolerated, the more actual conflicts can be reduced. Hence we need a method of synthesis that tolerates some level of disagreement without affecting the validity of the outcome.

Different people may have different levels of authority and expertise that need to be considered because they affect the outcome differently. Thus the method must be able to incorporate this situation in such a way that it shows in the outcome. Different people, moreover, may have different strengths of opinion. It is essential to quantify these intensities numerically in order to combine them and trade them off.

And finally, we will need a support system to facilitate the process. When it comes to complex problems, a systematic approach that is also comprehensive is both tedious and taxing. Relying strictly on the human mind aided by language is not only a slow process; it is not very reliable, either, because it does not really capture the different intensities of preference. The need for a support system is therefore inevitable. Our era of information technology and the internet makes it unnecessary for everyone to be present together in a room to make a collective decision. With the appropriate software, it is possible to distribute the tasks for the decision while keeping the whole process coherent.

**The AHP/ANP: A Credible Method**

The AHP/ANP we use in this book was constructed over a period of more than thirty years to meet the needs described in the previous section. Its well validated Fundamental Scale enables us to articulate judgments in a pairwise- comparison fashion to ensure accuracy. Decision making is inherently subjective because it involves intangible knowledge and tacit preferences. Although the human mind is inherently inconsistent, good decisions need a consistent mind. The AHP/ANP acknowledges this fact and incorporates it in its methodology deriving an inconsistency index that can be used to revise judgments for better accuracy. Its way of aggregating

group judgments ensures that the principle of rationality described later is maintained. The generalized way to synthesize judgments enables a group to structure a model that is as elaborate as desired. It also enables a group to integrate its knowledge collaboratively by structuring the problem together. It allows a group to acknowledge the disparate "power" of its members when eliciting their judgments. Further, it enhances the validity of the outcome by incorporating the importance of people's knowledge, the quality of their experience, and other factors. We will also describe ways to make group meetings more efficient — by reducing redundancy in judgments, for example, and not striving for perfect agreement and perfect consistency.

Collectively structuring the problem is a way for a group to aggregate its knowledge. Group members brainstorm the factors involved in the problem and consider how they influence each other. In this early stage, all inputs are accepted without conflict. The group may then decide how elaborate the model should be and tries to reach some kind of consensus. Since there is no rule as to how elaborate a structure should be, there is no harm in following a strong opinion. Constructing a model is an iterative process that the group can improve along the way. Synthesizing judgments, however, calls for a much higher level of agreement.

**How the AHP/ANP Supports Group Development**

In 1965, Bruce Tuckman introduced the four stages model of group development that has implications for decision making [33]. Group meetings may go through these stages several times in a cycle.

**First Stage: Forming**

The forming stage is the period when a group is just being established. They may or may not know each other well with respect to the task at hand. They explore each other's level of commitment as well as level of expertise and authority. They are not yet in the position to make a significant decision because they are still learning about each other. They will assess their relative importance with respect to guiding the decision-making process and offering judgments. Here people need to pay attention to the common problem of stereotyping based on first impressions.

**Second Stage: Storming**

The storming stage – also called the conflict stage – is where relationships and the power structure are challenged. The group may make poor decisions because of personality issues and self-oriented behavior. People may go along with decisions but not really support them. This is the "My position is …" stage. It may be the most challenging stage for the group facilitator because it is often highly emotional and competitive. Some people may behave self-righteously and refuse to listen to what others have to say. Cliques may be formed with an "us against them" attitude. All this is bound to reduce rationality and objectivity in group decision making. With creativity suppressed and solutions reached by vote or compromise, it is difficult for the group to come up with the best decision. The method we propose here offers a way for the facilitator to orchestrate the group process and prevent the negative effects just described.

**Third Stage: Norming**

The norming stage is also called the conflict resolution stage. Members coalesce around shared beliefs, values, and norms. This is the "I understand everybody's position and expect to be communicated with" stage. The group makes progress toward objectives by being constructive, open-minded, and less controlling. Group members trust each other to be candid and show creativity. Individual roles are better identified. The method we propose here advances the group to this stage faster by reducing the intensity of the storming stage. At this norming stage, group leadership may rotate from time to time. Thus a method that tracks the group's decision making reminds the group of its progress.

**Fourth Stage: Performing**

The performing stage is also called the "smoother-sailing" stage. Trust is now high among group members, who have aligned themselves to their common goal. This is an "OK, now we can get to work" stage, where information is shared freely and disagreement is acceptable. Later the group will enter the adjourning stage when the task is done and the group is formally terminated. The group has gone through a learning process that will prove invaluable when they work together again.

Any issue addressed by a group involves objectives, goals, criteria, a diversity of interests, influences, and multiple outcomes. All these need to be defined carefully and arranged within a structure that shows the flow of

influences. This structure with influences flowing from top to bottom may be a hierarchy or a network – a hierarchy is simply a special case of a network. By including all the factors, one major problem of settling differences of opinion is solved: nothing has been excluded.

Another problem is how to determine what is more important than what. Usually people have an idea of what is more and less important, but they need to measure both tangibles and intangibles in relative terms and indicate how much more important one factor is than another. To express this intensity of judgments in a meaningful way, we need numbers. Not only this, but we need to determine who is the more reliable judge because of knowledge and experience. Combining all the judgments to produce reliable priorities is the final step. We need a way to do all this. In fact we have such a way: the Analytic Hierarchy Process.

**Resolving Conflicts**

So far our discussion has proceeded along the lines of a group working together. Here we will talk about individuals or groups that may oppose each other – a situation that leads to conflict rather than harmony [34]. Most discussions on conflict start with the premise that there will always be winners and losers in any situation where people have opposing desires. Sometimes this is true. But it is often possible to find a compromise that will work, if only in the short run; in the long run, of course, it is usually necessary to remove the underlying source of the conflict. The best outcome will almost certainly fall short of each party's desired outcome. How can we persuade each party to accept the compromise solution? It is particularly necessary that people in conflict should use reason to make progress. But the two parties also need to develop a broader framework that offers benefits to both sides.

There are certain steps to be taken to understand the nature of a conflict:

1. Identification of the parties to the conflict
2. Identification of the objectives, needs, and desires of each party
3. Identification of possible outcomes of the conflicts or possible solutions
4. Assumptions about the way in which each party views its objectives and, in particular, its view of the relative importance of these objectives

5. Assumptions about the way in which each party would view the outcomes and the way in which a certain outcome might meet the objectives

An effective model of a conflict must include the emotional factors along with the rational. One major problem in modeling a conflict is to deal with intangibles. Attempts to apply rigorous logic to conflict are not new. Since the publication of Theory of Games and Economic Behavior (von Neumann and Morgenstern) in 1944, game theory has been an important tool for the study of conflict analysis. Indeed there have been many efforts to put conflict analysis on a rigorous and quantifiable foundation.

All conflicts require trade-offs for their solution. The method advanced in this book is unusually appealing because it can combine negatives like costs and risks with positives like benefits and opportunities. At the heart of the process, participants agree on the major issues involved in a conflict even if they disagree about their relative importance. Here we look at conflict in two ways. One approach is to determine the best outcome from the standpoint of representing each party's interests as articulated in a decision structure of benefits, opportunities, costs, and risks that are then combined to produce an overall best outcome from the standpoint of the diverse interests. We call this type of conflict resolution constructive or rational. The other approach to conflict resolution is retributive. In this case each party considers as a gain not only its benefits from the proposed solution but also the perceived costs to the other party. It is not concerned with the idea of fairness as in the rational approach. In many conflicts in which emotion and hatred are involved, parties aim to punish the other side by increasing its costs, perhaps to deter it from continuing the conflict.

**References**

1. MacKay, A.F. *Arrow's Theorem: The Paradox of Social Choice - A Case Study in the Philosophy of Economics*. New Haven: Yale University Press, 1980.
2. Keeney, R.L. and Raiffa, H., *Decisions with Multiple Objectives: Preferences and Value Tradeoffs,* New York: John Wiley & Sons, 1976.
3. Barbut, M. "Does the Majority Ever Rule? The Curious Operations of Processes of Rational Decision in Games and Practical Elections." *Portfolio and Art News Annual* 4 (1961):161-168.
4. Arrow, K.L. *Social Choice and Industrial Values*. New haven: Yale University Press, 1963.
5. Mirkin, B.G., *Group Choice*. New York: John Wiley & Sons, 1985.
6. Plott, C. Axiomatic Social Choice Theory: An Overview and Interpretation. *American Journal of Political Science* 20 (1976); **20**:511-596.
7. Saaty, T.L., *Fundamentals of Decision Making with the Analytic Hierarchy Process*. Pittsburgh: RWS Publications, 2000.
8. Saaty T.L. *Theory and Applications of the Analytic Network Process*. Pittsburgh: RWS publications, 2005.
9. Basak, I and T.L. Saaty, "Group Decision Making Using the Analytic Hierarchy Process", *Journal of Mathematical Modeling*. **17** (1993): 415.
10. Blumenthal, A. *The Process of Cognition.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1977.
11. Dehaene, S., *The Number Sense*: *How the Mind Creates Mathematics*. Oxford: Oxford University Press, 1997.
12. Haines, S.G. *The Systems Thinking Approach to Strategic Planning and Management*. St. Lucie Press, 2000.
13. Collins, J. *Good to Great: Why Some Companies Make the Leap … and Others Don't*. Collins, 2001.
14. Menkes, J. *Executive Intelligence,* Harper Collins World, 2005.
15. Tversky, A and D. Kahneman, "The Framing of Decisions and the Psychology of Choice", *Science* 211 (1981): 453-458.
16. Miller, G. A., "The Magical Number Seven Plus or Minus Two: Some Limits on our Capacity for Processing Information." *Psychological Review*. **63** (1956):.81-97.
17. Dweck, C.S. *Mindset: The New Psychology of Success*. New York: Random House, 2006.
18. Senge, P. *The Fifth Discipline: The Art & Practice of the Learning Organization*. Currency, 2006.

19. Bauer, R.A., E. Collar, and V. Tang. *The Silverlake Project*. New York: Oxford University Press, 1992.
20. Maslow, A. *Motivation and Personality*. New York: Harper & Row, 1954.
21. Rescher, N. *Introduction to Value Theory*. Englewood Cliffs, N.J.: Prentice-Hall, 1969.
22. Kaplan, R.S. and D.P. Norton *Balanced Scorecard: Translating Strategy into Actions*. Cambridge Harvard Business School. Press, 1996.
23. Kaplan, R.S. and D.P Norton *Strategy Maps: Converting Intangible Assets into Tangible Outcomes.* Cambridge: Harvard Business School Press, 2004.
24. Kaplan, R.S. and Norton, D.P., *Alignment: Using the Balanced Scorecard to Create Corporate Synergies.* Cambridge: Harvard Business School Press, 2006.
25. Imai, M. *Kaizen: The Key to Japan's Competitive Success,* New York: McGraw Hill/Irwin, 1986.
26. Romano, N.C. Jr. and J.F Nunamaker Jr. "Meeting Analysis: Findings from Research and Practice." *Proceedings of the 34th Annual Hawaii International Conference on System Sciences,* 2001.
27. Belbin, R.M., *Management Teams: Why They Succeed or Fail.* London: Butterworth-Heinemann, 1981.
28. Belbin, R.M. *Team Roles at Work,* London: Butterworth-Heinemann, 1993.
29. Saaty, T.L. and K.P. Kearns. *Analytical Planning: The Organization of Systems*; Oxford: Pergamon Press, 1985.
30. Romig, D.A. *Breakthrough Teamwork: Outstanding Results Using Structured Teamwork.* Irwin Professional Publisher, 1996.
31. Couger, J.D. *Creative Problem Solving and Opportunity Finding*. Boyd & Fraser, 1995.
32. Rescher, N. *Pluralism: Against the Demand for Consensus.* Oxford: Clarendon Press, 1993.
33. Tuckman, B.W. "Developmental Sequence in Small Groups." *Psychology Bulletin* **63** (1965):384-399.
34. Saaty, T.L. and J.M. Alexander *Conflict Resolution: The Analytic Hierarchy Approach*. New York: Praeger, 1989.