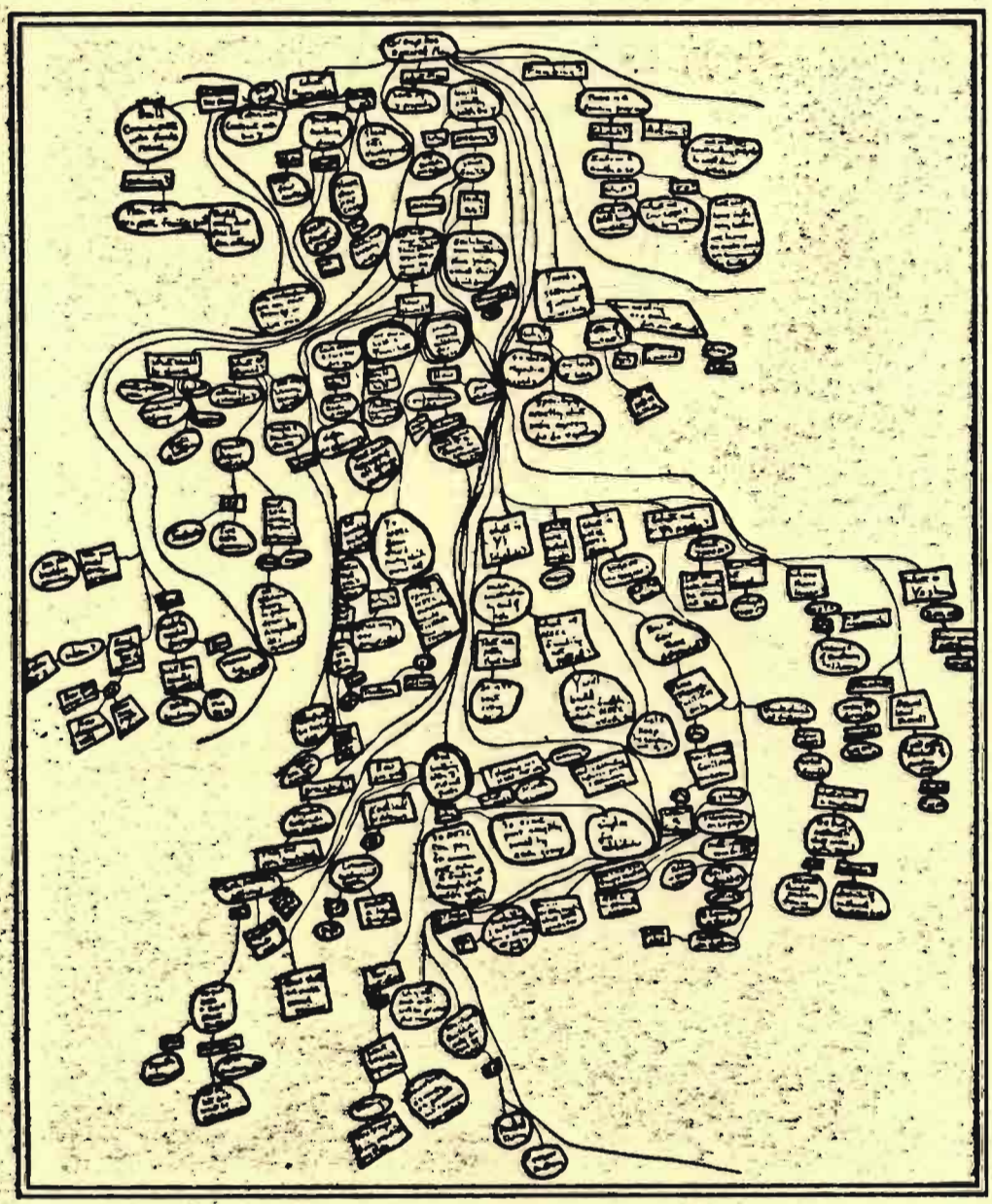
ISSUE ANALYSIS

An Introduction to the Use of Issue Trees and the Nature of Complex Reasoning



By David E. Wojick

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And the Nature of Complex Reasoning

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INTRODUCTION

How big is an issue? What makes an issue complex? Is one issue more complex than another? These questions may sound strange but exploration of a large number of complicated public issues suggests that there are answers--simple ones at that.

Several years of experimentation with various state and federal agencies has led our group at Carnegie-Mellon University to the conclusion that every issue has an underlying structure, one that can be literally 'mapped out' on paper, like an engineering drawing. Moreover, these drawings can be used to improve communication, understanding and the resolution of competing interests.

An issue is, by definition, a problem with several points of view. A public issue is an issue which involves action by a public agency, such as the Corps of Engineers or the EPA, and which may be national, regional or local, depending upon the circumstances. For example, the general issue of disposing of dredge spoils involves national concern and attention, while dredging a particular river may be a regional issue and the choice of a particular disposal site is often a big local issue.

Several years ago we become concerned that the public was not aware of the great complexity of the many environmental and energy-related issues that were then being raised. To try a new approach to the problem of complex public issues, we 'atomized' an issue by taking every single statement we could find on that issue and then attempting to fit all of these statements together into a coherent whole.

The results were startling: we found to our dismay that the statements, several thousand in all, fit together into a simple logical pattern.

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The issue, while very complex, turned out to have a relatively simple underlying logical structure.

Moreover, once this structure was grasped it was easy to see how one main issue, in this case auto energy use, divided itself into several major sub-issues. Each of these sub-issues was further found to be itself divided into sub-issues, which were in turn divided, etc. Because the resulting heirarchical structure is called a 'tree' by mathematicians, we called our discovery an "issue tree".

Since that first discovery, a large number of issue trees have been contructed, all revealing variations of the same basic underlying form - the tree. We have also experimented extensively with using issue trees to improve communication and understanding where complex issues are involved.

This work was carried out initially under a grant from the Carnegie Corporation. Practical applications were then tested with a number of urban planning firms, as well as with several public agencies including The Pennsylvania Governor's Energy Council and The Corps' Waterways Experiment Station. Through this field work we were able to establish certain benchmarks for the size of issues.

The number of points required to resolve on issue will vary with the number of factors that must be considered as well as the level of detail that must be reached. In general, the addition of a new factor results in a simple percentage increase in the size of the tree while adding another level of detail results in an exponential increase in the point count.

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A typical local issue, for example, if discussed to the level of detail necessary to begin resolving conflicting interests, will yield an issue tree of from 1000 to 10,000 statements, or 'points'.

For a major national issue such as how to achieve energy conservation hundreds of thousands, if not millions, of points must be put together before the issue will be resolved.

Building and using issue trees has shed considerable light on the problem of efficient communication, understanding and resolution of conflicting points of view. For example, while 2,000 points might typically have to be grasped to get a good understanding of an issue, people usually produce only about 100 to 150 points per hour. This means that it takes a lot of careful attention to really work through an issue, attention which people are often unwilling or unable to sustain. We believe that this single fact--the very size of most issues--accounts for a great deal of the difficulty which often attends the resolution of public issues.

Moreover, because the underlying structure of an issue is tree-like, that is, because very often several points take off from a single point, it is easy to get lost in the detailed sub-issues of an issue. As a result at least four things often happen when people try to discuss a complex issue:

(a) different people may want to go in different directions, that is, to follow different 'lines of thought' or sequences of points. This leads to tension and frustration.

(b) the need to continually return to certain points so as to re-orient oneself in the tree leads to seemingly end-

less repetition, which causes boredom and further frustration.

(c) because of the complexity of the tree structure it is relatively easy to 'lose the thread' of the discussion. Even an entire group may lose track of where they are or, alternatively, someone may make a point which no one else can follow, because he or she has misjudged the location of the discussion in the tree.

(d) because of the multiplicity of pathways which must be worked through for an issue to be resolved, it is almost certain that important points will be missed the first few times an issue is examined. Such oversights may lead to a sense of the incompleteness of current discussion, as well as misunderstanding and mis-trust later on.

Believing that many of the problems of efficient issue resolution stem directly from the complex structure of most issues, we have experimented extensively with helping people understand the structure of issues in order to resolve those issues. There are basically three ways of helping; which we call, respectively, the display, the analytical and the interactive uses of issue trees. These are as follows:

(1) In the display case, a preliminary issue tree is prepared and used as a format or framework for the discussion of some issue. This helps prevent confusion and getting lost.

(2) In the analytical case, pre-existing discussions of an issue are 'tree' d-out' to determine just what the issues

are. The resulting tree may be analyzed for such things as confusions, mis-understandings, unresolved issues, potential conflicts, etc.

(3) The interactive use of issue trees is really a combination of the analytical and the display uses in that the tree of one discussion is used as the format for a succeeding discussion, either by the same group or by new people. In this way a systematic discussion may be sustained over a long time. Moreover, a great variety of opinions may be collected and made to interact even though only a few people participate at at time. This use of issue trees is the most efficient in terms of rapid identification of the extent of an issue and the alternatives for its resolution.

One of the most extensive applications of issue analysis to date was a project, undertaken by The Pennsylvania Governor's Science Advisory Committee, to investigate points of conflict between evergy, environmental and economic policy. Using the interactive issue tree approach the testimony of more than one hundred experts, taken over several months, was boiled down to the most critical 150 points for executive attention. As a result of this project we have also begun to experiment under a grant from NSF, with issue analysis at a technique for project evaluation and for technology assessment.

To date a considerable number of people have been trained at Carnegie-Mellon in the building of issue trees. The task seems to be about as difficult as using a hand calculator, with the same range of sophistication. In an

hour one can learn the basic principles and how to recognize simple patterns. About a week seems to be necessary for sophisticated practice. A really proficient issue analyst can draw the tree of a discussion as the discussion proceeds.

The key to building issue trees is the fact that when an issue is discussed, almost every point made is directed or aimed at some other point that has already been made. Building a tree consists of identifying each point and its target. There are only five kinds of points: opening statements, questions, answers, objections and replies. Each path through a tree represents a single line of thought, or sequence of points proceeding from an opening statement. Each line of thought reads like a dialog between two people, who alternatively ask questions of one another and reply to these, or object to each others questions, or to the replies, etc.

The tree structure occurs because often several points may be directed at a single point: several answers may be proposed to a single question, several objections may be lodged against a single answer, etc. This 'branching' of thought is what makes an issue complex and difficult to grasp in detail.

It seems to be an inescapable fact about reasoning that we are always struggling, point by point and thought by thought, to grasp what is in actuality a complex system of ideas. Considering the complexity of most issues, we do quite well. Hopefully, understanding this complexity will be useful in improving our ability to grasp important issues. Our experiments to date have indicated that this is so.

ISSUE ANALYSIS

CHAPTER I: POINTS AND MOVES

A. CASE I: The Ford Argument

B "Why in the world did you buy a Ford?" (1)

A "Because I think that Fords are very reliable." (2)

B "What evidence could you possibly have for that? Don't you know that Motor Trend magazine's 'frequency of repair' statistics indicate that Fords are terrible?" (3)

A "What do you mean by 'terrible'? Motor Trend is biased, a friend of mine told me they are controlled by General Motors." (4)

B "That's nonsense. I don't know why you don't like Motor Trend, but I know why I don't like Fords: I own one and it's a lemon." (5)

A "Your car isn't a lemon. Your son hot rods it all the time, that's all. Besides, why do you say it's a lemon? You haven't had that much trouble." (6)

B "Listen, my son drives better than yours does. Besides, he has his own car." (7)

What occurs above is obviously a discussion on Ford motor cars. More specifically, the parties involved are arguing the idea that one might buy a Ford on the basis of its reliability. In fact, the entire dialog demonstrates reasoning about an issue, in this case, the issue of the reliability of Fords.

This type of activity, termed Complex Reasoning, will be the topic of study in the next few chapters. Complex reasoning is not new to most of us; in fact, one should recognize his own use of this kind of reasoning both in participation in discussions similar to the one above, and also in cases of 'thinking through' a problem alone. But while not new to most and even common to many of us, there are certain aspects of the underlying structure of complex reasoning that can be useful once analyzed and understood. To aid in the achievement of this understanding of the underlying structure constitutes the central purpose of this text.

The closer examination below of Case I (The Ford Argument) will make it clear that the complexity of this issue of buying a Ford increases as the discussion continues and new lines of argument are introduced. Important considerations then shall be the source and form of the complexity, and how this complexity develops as the discussion progresses.

B. The Ford Argument Analyzed

The Ford Argument begins with a question - a request for an explanation for a specific action - that of buying a Ford.

(1) "Why in the world did you buy a Ford?"

Such a question asks for a reason, and this reason is forthcoming in the second statement where reliability is offered as a reason, and the sides of the argument are drawn.

(2) "Because I think that Fords are very reliable."

The next response is threefold, assuming the form of a question and a compound statement.

(3) "What evidence could you possibly have for that? Don't you know that Motor Trend magazine's 'frequency of repair' statistics indicate that Fords are terrible?"

The question asks for evidence in support of the supposed reliability of Fords, while the statement raises basically two points: 1) there is statistical evidence against the reliability of Fords, and 2) the source of that evidence is Motor Trend magazine. (Note: although technically speaking, B's response here consists of two questions, the second of the two takes the form of a question not because an answer is sought, but rather to add emphasis to what "B" considers to be a statement of fact - that Motor Trend's statistics show that Fords are terrible.)

Thus far these five things have happened that increase complexity: a request by "B" for a reason; a reason offered by "A"; "B's" request for evidence in support of that reason; his offer of evidence against the stated reason; and, finally, his offer of a source for that evidence. The subsequent response further contributes to this already growing complexity.

"A" now asks for a definition or explanation of 'terrible' as used by "B" to interpret Motor Trend's statistics.

(4) "What do you mean by 'terrible'?"

Then A launches a direct attack on Motor Trend magazine as being an unreasonable source of evidence against Fords, by claiming that Motor Trend is biased for the reason that the magazine is controlled by a competitor of Ford.

(4) "Motor Trend is biased, a friend of mine told me they are controlled by General Motors."

Moreover, "A" offers a source for the evidence against Motor Trend, namely, 'a friend'. In total, four points are made in "A's" response: (1) a request for a definition or explanation, (2) a claim against a source of evidence (Motor Trend) which was itself used as a source of evidence against a reason (reliability), (3) a reason for that claim, and (4) a source of evidence for that reason.

Thus, after each party has spoken only twice, exactly nine points or moves have been made; four by "B" and five by "A". Clearly, a point or move can be either a question or statement, provided that it is directed toward some other point or move that has already been made. (Note: the terms "point" and "move" will be used interchangeably for the moment. Once the moves in this argument are identified, the problem of the arrangement of these moves in terms of an underlying logical stucture will be

considered in Chapter III. At that time, a distinction between a "point" and a "move" will be made.)

"B's" next response to "A" first suggests that what "A" has just said about Motor Trend is nonsense.

(5) "That's nonsense. I don't know why you don't like Motor Trend, but I know why I don't like Fords: I own one and it's a lemon."

This constitutes a direct objection to one of "A's" claims. However, this objection remains ambiguous in that it is not clear whether "B" is denying that Motor Trend is biased, or rather denying that General Motors controls the magazine. Presumably it is the former case. More significant stands that fact that "B" now has introduced a new line of argument in that he offers his own car as evidence against the reliability of Fords. The seven points made prior to this statement have all been directed to the issue of Motor Trend's statistics as evidence against Fords. By offering his own car as evidence, "B" has abandoned the issue of Motor Trend's statistics and, in effect, has returned to the original issue of Ford's reliability per se. (Notice that only two points were actually made by "B" in this response; the "I don't know ... but I know" statement does not serve to raise points but rather to discontinue the old line of thought and to introduce the new one.)

In continuation, "A" responds in a fairly straightforward manner by making an objection to the claim that "B's" car is a lemon - an objection based on an alternative reason for the evidence (ie. B's troubles), namely, his son.

(6) "Your car isn't a lemon. Your son hot rods it, that's all. Besides, why do you say it's a lemon? You haven't had that much trouble."

A second objection is also made, an objection composed of a questioning of the claim that the car is, in fact, a lemon. This objection is based on the evidence that "B" has not had much trouble with his Ford. (Note, by the way, that these two objections are somewhat inconsistent: if "B's" son is a reason for his troubles then he has had troubles, which is denied in the second objection. This occurence, wherein several objections which are not actually consistent with one another, are pursued simultaneously, is not unusual).

Finally, "B" chooses to respond to the first, and more personal, of "A's" objections.

(7) "Listen, my son drives better than yours does. Besides, he has his own car."

He offers two distinct pieces of evidence against the claim that his son contributes to his car troubles: (1) that his son is a good driver - at any rate, better than "A's", and (2) that his son does not even drive the car in question. "B" undoubtably finds the first of these two responses more personally satisfying, but the second response makes the first somewhat irrelevent.

The object of this analysis of the Ford Argument is to create an understanding of it, rather than to decide it. One can observe, however, that while the issue remains unresolved, "B's" case is developing. For example, "B" has successfully defended his son's driving ability, and hence, his own car as evidence against Fords' reliability. However, he has yet to reply to the claim that he has not, in fact, had that much trouble with his car. "A", on the other hand, has not been too successful in his attack on Motor Trend, although he has raised the issue as to whether the statistics are really 'terrible' for Fords. "A" might also, of course, shift his ground altogether and offer

some basic reason other than reliability - such as that of always having bought Fords = for buying a Ford.

At this point, however, it is most important to realize that the argument has already become quite complex with many moves at various levels, and that it will continue to grow in complexity on further development. Once the important idea of making moves and counter-moves in a discussion is grasped, one can then begin to observe how these moves compose certain patterns. Indeed, and as will be demonstrated in the next few chapters, all complex reasoning can be analyzed as a system of moves with an underlying structure or pattern. A practical understanding of this structure can be an aid in improving one's own reasoning and in understanding the reasoning of others.

C. Chapter I: Exercises

1. Make up various continuations of the "Ford Argument", adding at least four responses of from two to four moves each, as follows:

   a. Where "A" defends his son's driving ability.
   b. Where "B" defends the claim that his car is a lemon (Begin by adding to "B's" last response).
   c. Where "A" defends the claim that General Motors controls Motor Trend magazine.
   d. Where "A" introduces a new reason for buying a Ford.

2. Identify the points or moves added in Exercise 1, above, and try to give a general characterization of each. (General characterization are underlined descriptions, such as "giving a reason", "offering evidence against", etc, which we gave in analyzing the "Ford Argument". (See Exercise 5, below).

3. Make up a discussion of at least thirty moves on the following: (You can, if you wish, make these three or four-way discussions.)

   a. Automobiles should be banned from all urban areas.
   b. We should stop building nuclear power plants.
   c. Abortion should be legal and easy.
   d. Cigarette smoking should be prohibited by law.
   e. Everyone should have the same income.
   f. God Exists
   g. Columbus discovered America.

4. Identify the points or moves made in each discussion developed in Exercise 3, above.

5. Make up an argument on any topic where each move has the same general characterization as the corresponding move in the Ford Argument, ie.:

   B Asks for a reason

   A Gives a reason

   B Asks for evidence for the reason, offers evidence against the reason and gives a source for that evidence.

6. Do the same for the argument you developed in Exercise 1.

7. Ditto for Exercise 3.

CHAPTER II: TARGETS AND TREES

A. Introduction

Reasoning is an evaluative process. Generally, reasons are given either in support of or against the performance of certain actions or the holding of certain beliefs. Thus, when one reasons, some course of action, a belief, or a problem is at issue, and to explore that issue, typically with the ultimate goal of making a decision upon it, constitutes the object of reasoning.

However, reasoning can be more than the mere giving of reasons in favor of, or against, the acceptance of a specific belief or action - more, because reasons themselves are often evaluated or reasoned about. As observed in the Ford Argument, the offer of dependability or reliability as a reason for buying a Ford might be challenged in a number of different ways, such as through citing statistical evidence to the contrary, requesting specific evidence of that reliability, or even by pointing out that one's own Ford is a lemon. In turn, these challenges might also be responded to in a variety of ways, such as through challenging the relevance of the source of the cited statistics, through attributing one's own problems with his Ford to his son's driving habits, etc.

Clearly, the argument can become complicated quite quickly. However, throughout the entire discussion, both parties reason about the same issue: the advisibility of buying a Ford. Observe that this primary issue includes many sub-issues, such as that of reliability, and the sub-issue of reliability itself includes

numerous other sub-issues, such as the relevance of certain statistics, how one's son drives, etc.

The basis of issue trees is just this fact - that when one reasons, one must reason about one's reasons, supporting them with other reasons and offering reasons against the reasons which are offered against them. Considered in this light, the reasoning process can become quite complex. We have found, for example, that a group of well-informed, articulate people can easily make 100 points in an hour while dealing with a single issue. Moreover, a truly complex issue may involve several thousand distinct points. However, these thousands of points do not lack structure. Indeed, they form a distinct pattern, and this pattern, called an issue tree, will now be explored.

B. Treeing the Ford Argument

A still closer examination of the Ford Argument reveals that when either "A" or "B" responded to one another, they did more than just respond in a general way to 'what had been said'. It is rather the case that each point made was specifically directed to a particular point previously generated. Each point had a target, ie. one specific point to which it was a specific response. Illustrations of this might be:

1) When "A" asked, "What do you mean by 'terrible'?", his question acted as a direct response to "B's" claim that certain statistics (found in Motor Trend - anotherpoint) showed that Ford's were terrible. Thus, "B's" claim constituted the target of "A's" question.

2) "B's" statement that his Ford was a lemon was aimed at "A's" claim that Fords were reliable, which, in turn, was aimed at answering "B's" original question as to why "A" bought a Ford.

3) "A's" accusation against "B's" son became the target for two distinct points raised in "B's" final response.

A graphic representation would clarify this "point/target point" concept. Two points appear on the page, the first above the second, with a line drawn between them. (NOte: in the interest of saving space, some of the points will appear in an acceptable abbreviated form.)

Thus, for the three examples discussed above, one would construct the following:

(1) Statistics show 'terrible' (B)
|
What do you mean by 'terrible'? (A)

(2) Why buy a Ford? (B)
|
Fords are reliable (A)
|
My Ford is a lemon. (B)

(3) Your son's driving is the problem (A)
Better than yours — Has his own car (B)

Moreover, at least one of the points in each example is related to at least one of the points in the other two examples, as depicted below:

FIGURE X

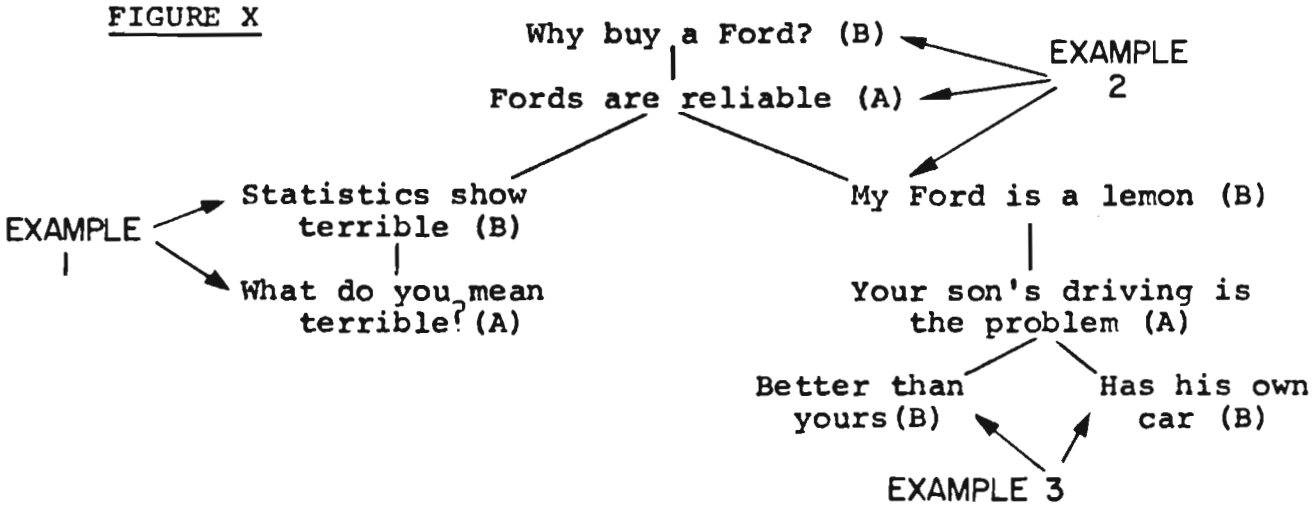


Figure X is an Issue Tree; an issue tree of a segment of the Ford Argument. (The word "tree" as used here, derives from the mathematical term, "tree", used to describe all patterns that branch, as in Figure X, even if the branching is drawn up-side-down.) This issue tree lays out graphically many of the complex aspects of the Ford Argument. For example, it demonstrates quite clearly, how B 'backed up' and initiated a new 'line of thought' upon making the point that his Ford was a lemon.

In general, an issue tree portrays just how each of its member points are related to one another (ie. how they fit together to form an issue) because trees make explicit the underlying logical structure of reasoning - a structure which exists there all the time; one which each of us understands implicitly when we reason, but which we seldom grasp in its entirety. Upon completion, in this chapter, of the issue tree of the Ford Argument (Ford Tree), some of the rules for building issue trees will be presented in the next chapter, followed by a description of some of the various ways issue trees can be used to aid in the understanding of complex reasoning.

Given the framework already presented, it will be a simple matter to attach the remaining points of the Ford Argument to its tree, with the exception of a couple of tricky points. These so-called "tricky" points are the ones in which several points are made simultaneously, such as in cases where sources are cited for evidence (ie., where "B" cites Motor Trend magazine or where "A" cites 'a friend'). The difficulty with these points is that of determining to which points these points are directed.

In "B's" case, "A" has just said that Fords are reliable, to which "B" responds with two points: statistics exist which show otherwise, and these statistics can be found in Motor Trend. These points, however, are not independent, but rather one is subsidiary to the other. B might have mentioned that there were unfavorable statistics without having made mention of Motor Trend, but not vica versa, for it would have made little sense to only have said Motor Trend without having first referred to the statistics. In other words, the point about Motor Trend magazine merely expands on or adds to the point about the terrible statistics, by answering the unstated question, "Whose statistics?". For this reason "B's" two points whould be represented in this order:*

Statistics show terrible (B)
|
Whose Statistics? (Unstated)
|
Motor Trend Magazine's (B)

---

*Admittedly, a compound point such as B's can be broken in several ways. For the example under consideration, acceptable breakdowns might be any of the following:

(1) Motor Trend's statistics say otherwise (B)
|
What say? (U.S.) (U.S. = Unstated)
|
Fords are terrible (B)

(2) Motor Trend says otherwise (B)

How so? (U.S.) — What say? (U.S.)
|
Statistics (B) — Fords are terrible (B)

(3) A magazine says otherwise (B)

Which one? (U.S.) — How so? (U.S.) — What say? (U.S.)
|
Motor Trend (B) — Statistics (B) — Fords are terrible (B)

Similarly, "A's" citing a source demands a representation like the following:

Controlled by General Motors (A)
|
Who says? (U.S.)
|
A friend (A)

Note that "(U.S.)" has been used to indicate unstated points, which occur fairly often, particularly when a single person makes many points simultaneously. An extreme case of unstated point use is individual thought, in which many of the questions that carry an issue downward are omitted. Obviously, unstated points can be a potential source of confusion and lack of succession in reasoning. In any event, with the unstated questions or points resolved, the final Ford Tree would look like the one in Figure Y.

In principle, however, there is no vagueness, for a total analysis of each statement could be performed based upon what is known as a Russell Analysis. Moreover, in actual practice, the possibility of alternative formulations of clusters of points causes little trouble.

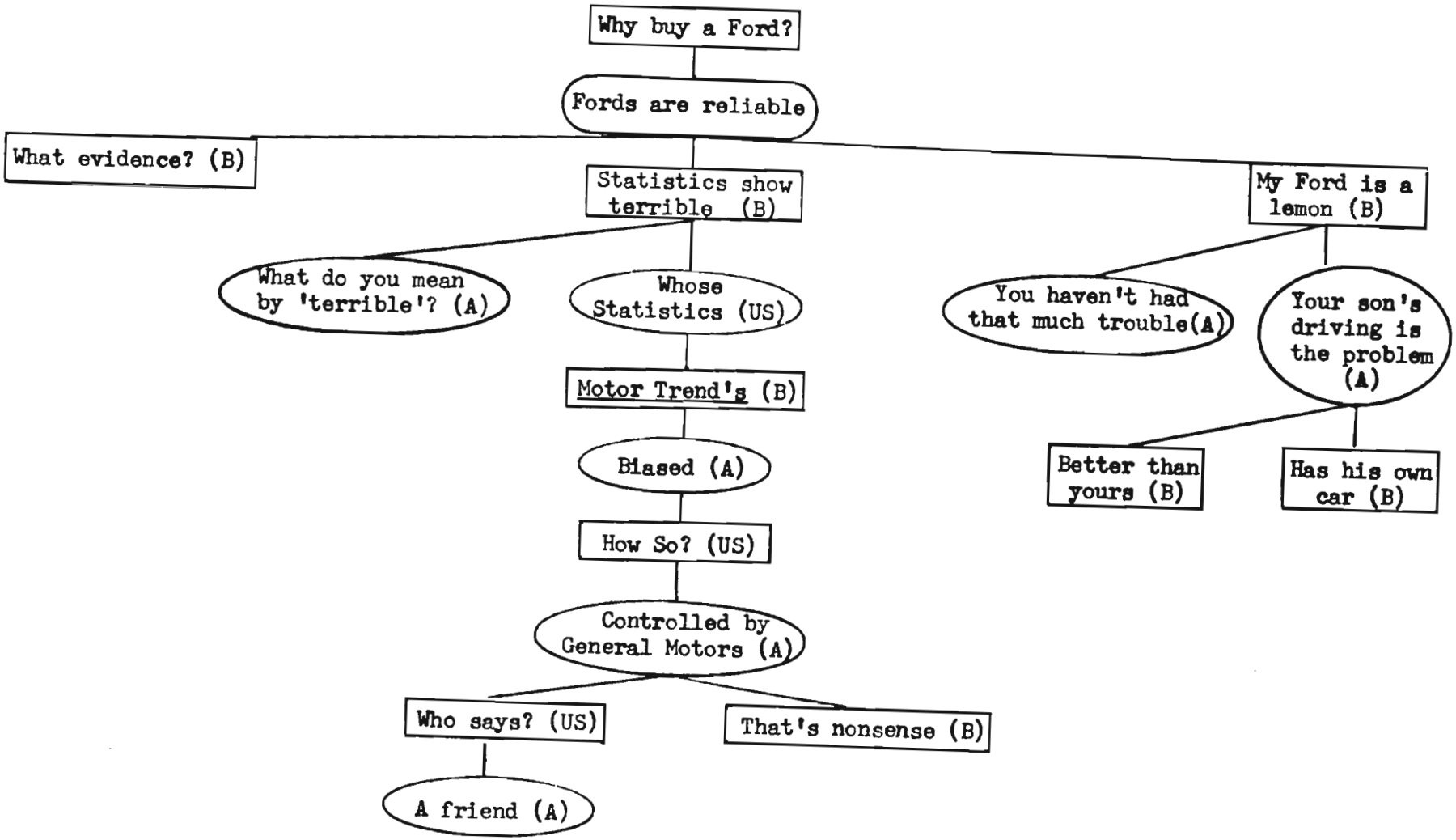

Why buy a Ford?
Fords are reliable
What evidence? (B)
Statistics show terrible (B)
My Ford is a lemon (B)
What do you mean by 'terrible'? (A)
Whose Statistics (US)
You haven't had that much trouble(A)
Your son's driving is the problem (A)
Motor Trend's (B)
Better than yours (B)
Has his own car (B)
Biased (A)
How So? (US)
Controlled by General Motors (A)
Who says? (US)
That's nonsense (B)
A friend (A)

FIGURE Y

C. The Idea of the Issue Tree

Although hardly surprising that reasoning proceeds with many points made on each side, few people seem to realize the true magnitude of most issues. More interesting, however, than the mere magnitude of reasoning, is the tree-like pattern which reasoning typically assumes. Upon careful consideration of the Ford Argument (Figure Y), one will observe that the reasons presented in the argument arrange themselves, according to their logical or epistemic relations to one another, into a tree-like form with many distinct levels. Each level contains the responses of one side to the points made by the other side in the level above. Branching occurs because a given point often may be responded to in several ways, (ie., there were three responses to the claim that Fords ought to be bought for their reliability and two responses to the counter-claim that statistics show otherwise.)

Note that this tree arrangement does not proceed arbitrarily. The point of a statement determines its location in the tree, so that, while ambiguities might give a point two possible locations and compound points might be broken down in slightly different ways, a given discussion or issue, in general, breaks down into one unique tree.

Each new point introduces a sub-tree which becomes an integral part of the overall issue and which may grow as discussion proceeds. For example, in Figure Y the issue of the reasons for buying a Ford consists entirely of the sub-issue of their reliability. This issue in turn, consists of the sub-issues of the evidence of reliability, a given item of statistical evidence

against reliability, and the sad state of "B's" own Ford, respectively. Observe how each of these sub-issues can grow, both horizontally and vertically as discussion progresses. One possible result of such growth is shown schematically in Figure Z with an issue tree of 10 levels and more than 60 points. (Note: the reader is invited to consider possible entries for the blank nodes on the tree, the only stipulation being that each point must be a logical response to the point above. Merely rhetorical responses, such as abuse, are not allowed. The concept of "logical" as used to describe the structure of issue trees, will be developed further in later chapters.)

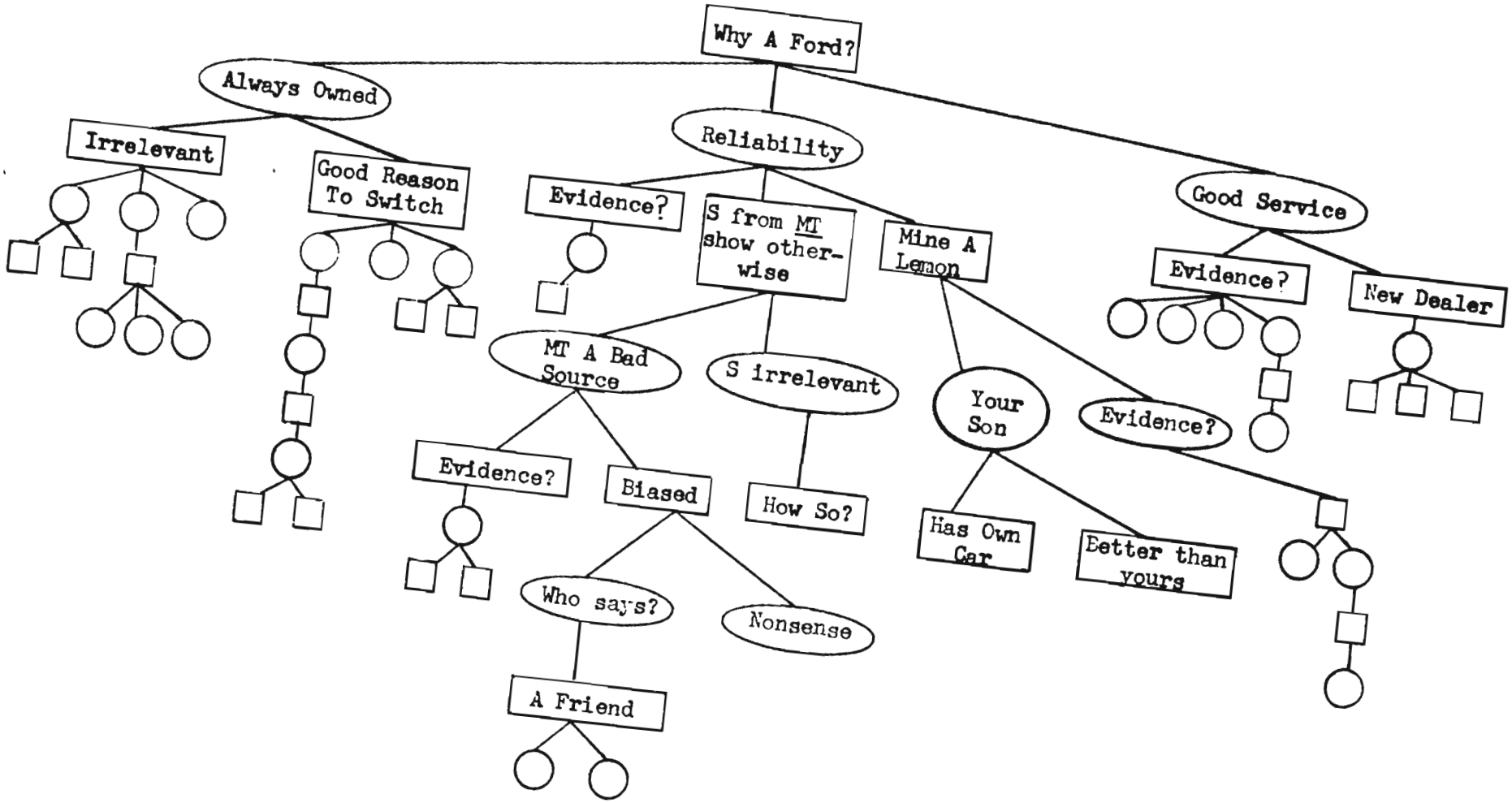
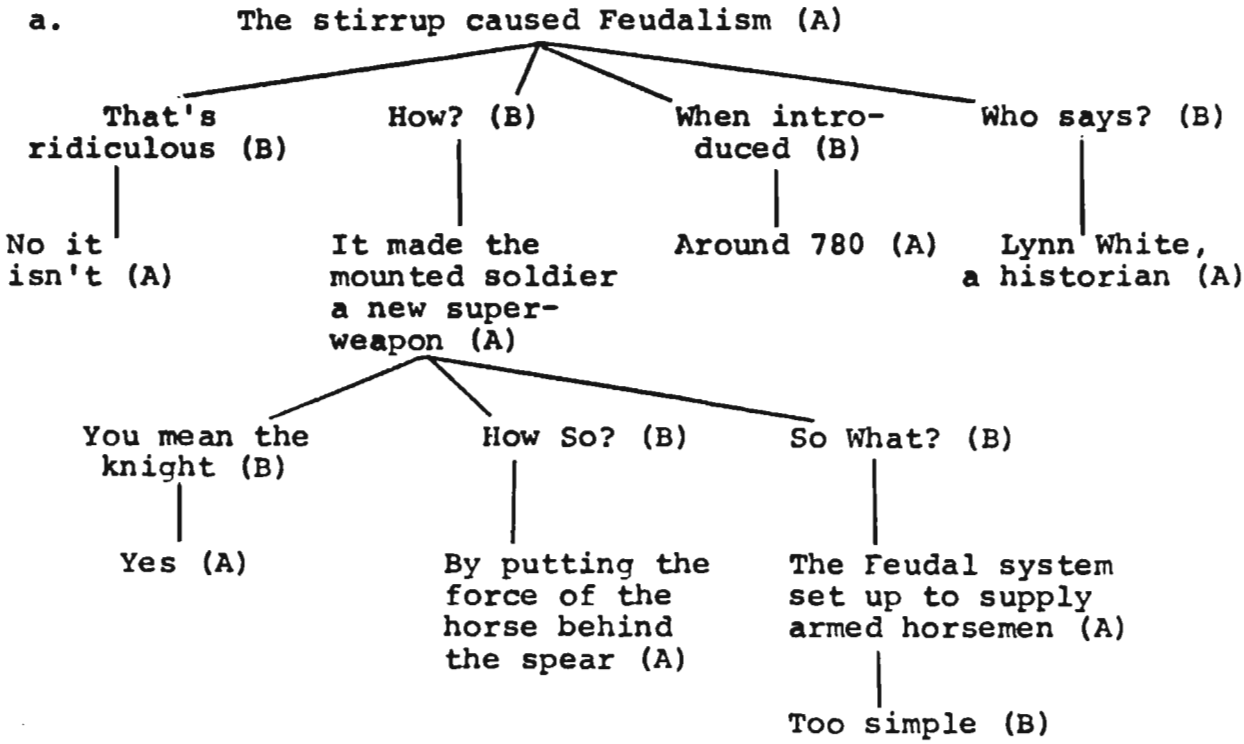

Why A Ford?
Always Owned
Irrelevant
Good Reason To Switch
Reliability
Evidence?
S from MT show otherwise
Mine A Lemon
Good Service
Evidence?
New Dealer
MT A Bad Source
S irrelevant
Evidence?
Biased
How So?
Your Son
Evidence?
Has Own Car
Better than yours
Who says?
Nonsense
A Friend

FIGURE 2

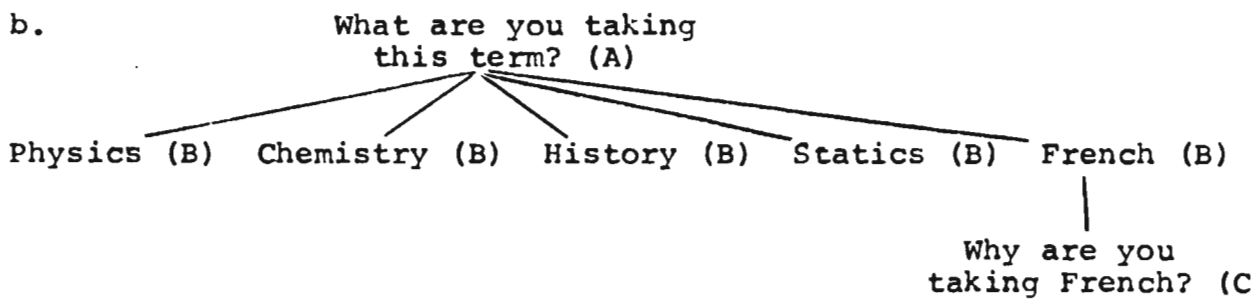
D. CHAPTER II: Exercises

1. Translate each of the following issue trees into a dialog form:

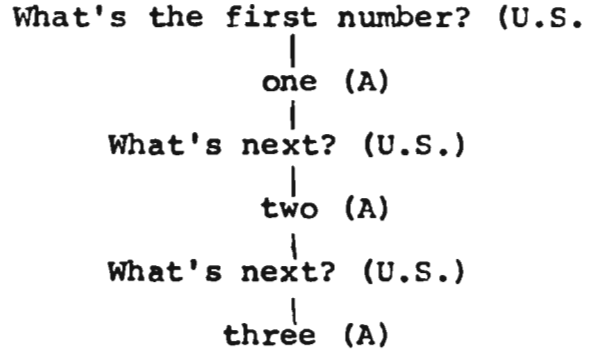
a.



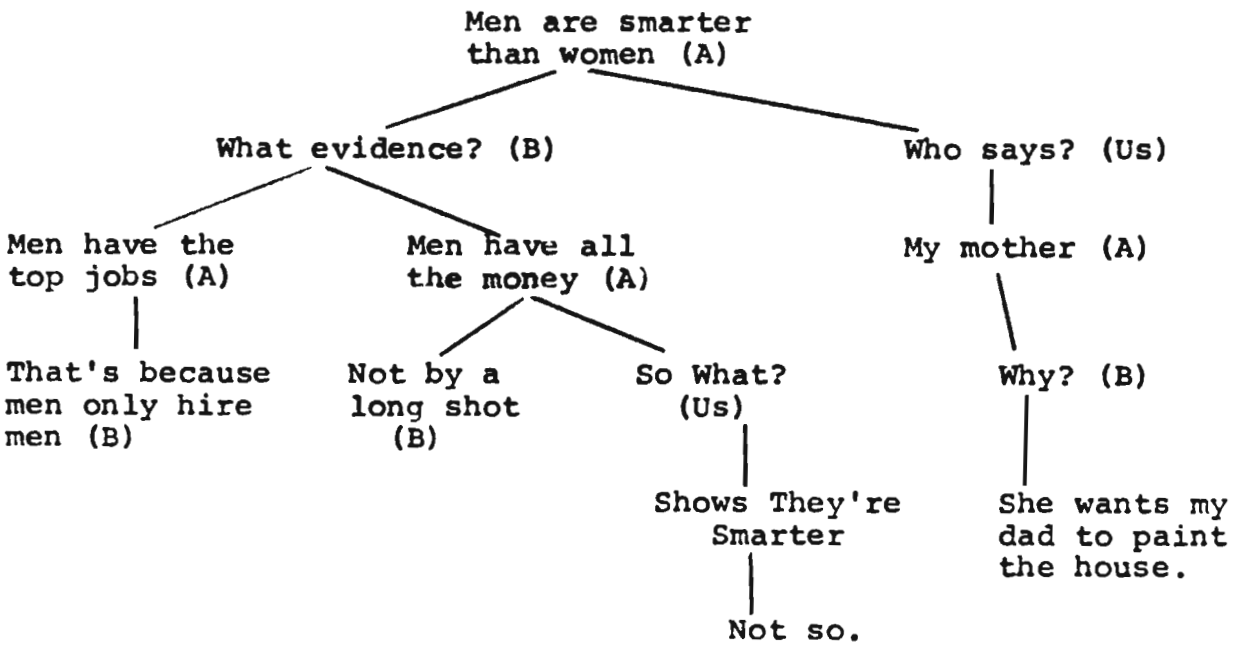
b.



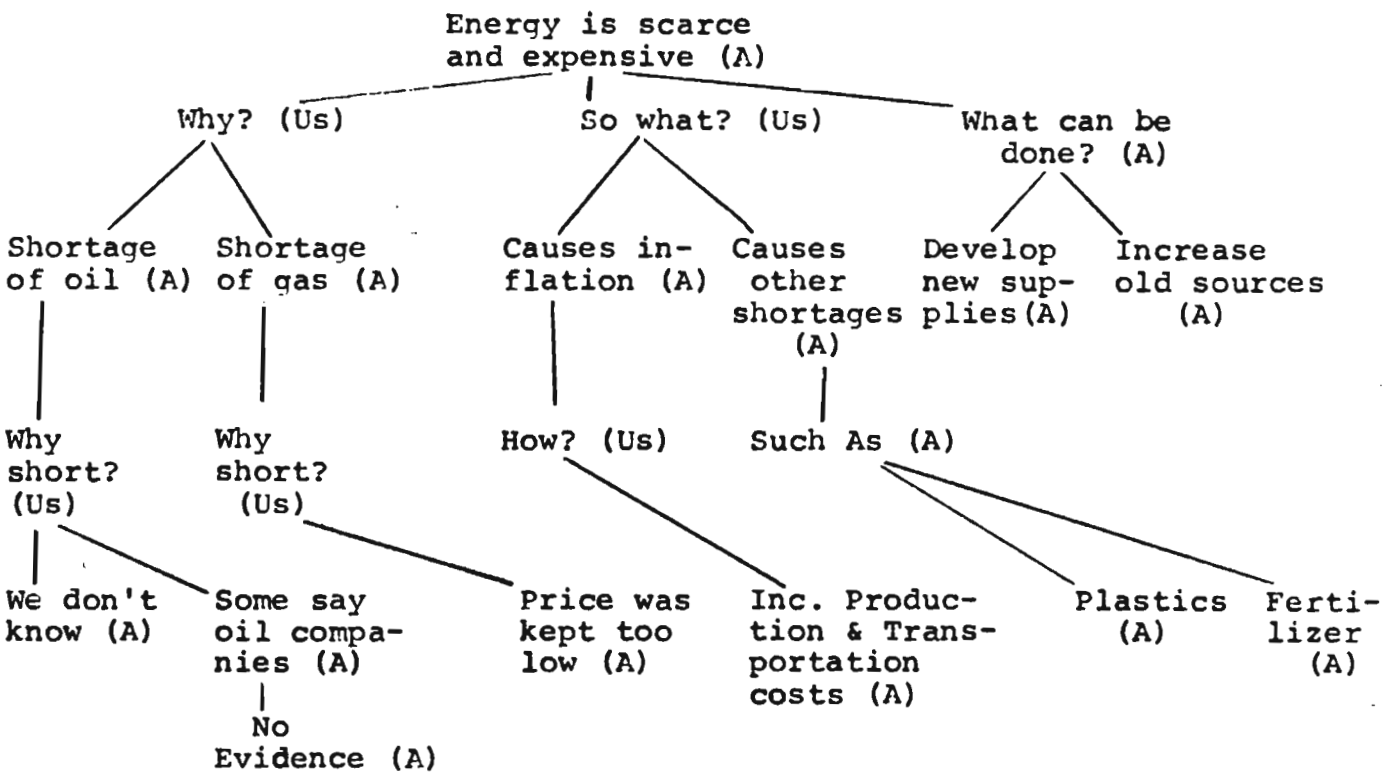
c.



2. Different discussions may have the same issue tree because the same points may be made in more than one order. To see this, translate the following issue tree into two different discussions:



3. Even a lecture has an underlying issue tree. Translate the following into a lecture:

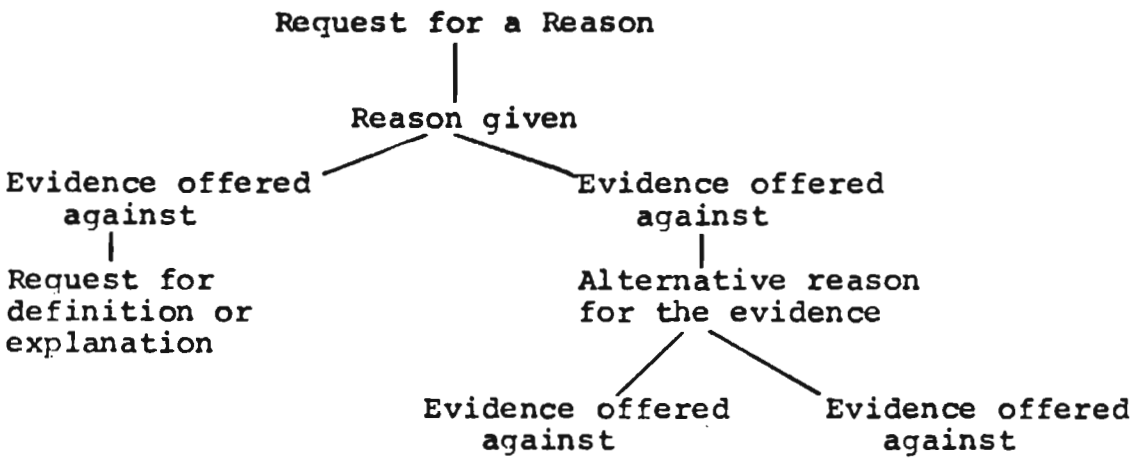


4. Add to the Ford Tree all the continuations you developed in Exercise 1, Chapter 1.

5. Build issue trees for each of the dialogs you developed in Exercise 3, Chapter I.

6. Build issue trees for each of the dialogs developed in Exercise 5, Chapter I.

7. Just as there is a general characterization of every discussion, so there is a general characterization tree (G-C tree). For example, the part of the Ford Tree shown in Figure X has the following general characterization tree:



a. Construct the general characterization tree for the complete Ford Argument.

b. Extend the G-C tree of the Ford Argument to include the points added in Exercise 1, Chapter I.

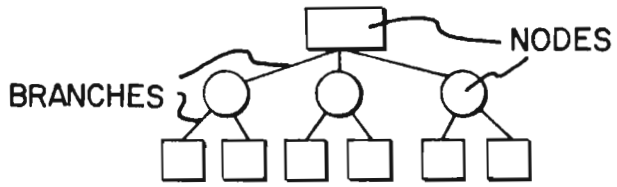
c. Build G-C trees for each of the dialogs developed in Exercise 3, Chapter I.

d. Likewise for Exercise 5, Chapter I.

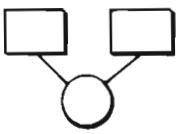
CHAPTER III: RULES FOR BUILDING ISSUE TREES

A. Trees

"Tree" is a concept in mathematics. A tree consists of nodes connected by branches, like this:



A path is a descending sequence of branches connecting any given node to other given nodes. In a tree there can be only one branch connecting any two nodes and two paths, once separate, never come back together like this.



WRONG!

B. Issue Trees

In an issue tree, each node represents a point in an issue, that is, a brief statement or question about an issue (See Chapter I). Each branch identifies a move or the transition from one point to the next. Making a statement or raising a question in response to a given point constitutes making a move, (a penetrating question or objection is sometimes said to be a 'good move'). Any path in an issue tree represents a line of reasoning, - a sequence of points made in response to one another (See Chapter II).

C. Uncovering the Issues

In the Exercises in Chapter II, the student was required to build issue trees of arguments he had made up himself. Now

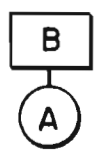
it will be important to learn to 'tree out' an issue that has already occurred. Magazine or newspaper articles dealing with the good and bad aspects of an issue or idea can be good sources.

To start the tree, simply take any point made about the issue under discussion, and write a short, concise statement of it (4-5 words, if possible). This point may be a question, an objection, or a statement of fact. Draw a circle or oval around it, and then consider two things:

(1) Is this point a response to another point in the article?

(2) Are there other points in the article made in response to the chosen point?

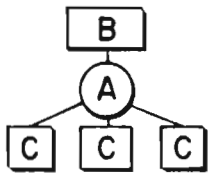
If the point selected is a question, what statement does it question?; if it is an objection, what claim is being challenged?; if it is a statement of fact, what question is being answered? At this stage, absolute accuracy will not be crucial nor is it necessary to determine the top point first. What each point should be and where it should be located, will become evident as the issue tree expands. The important idea, however, is that the point in question be an <u>immediate</u> response to only <u>one other point</u>, unless it is the top point, in which case it is not a response to any other point. Decide what that other point is, write it down <u>above</u> the first point, and draw a <u>box</u> around it. Connect the box to the circle with a line, like this:



One now has a tree composed of two nodes and one branch, representing two points and one move. The move is downward - from the point in the box to the point in the circle. (The

boxes and circles are used to aid in visually defining the two sides of the issue.)

Next, consider the points that are made in response to the point in the circle - several may occur. For example, if the point in the circle is a question, the response to it may be a counter-question, an objection to the question, or even several answers, each of which would be a response, (remember the Ford Argument). Whatever the case, take the responses to the point in the circle, arrange them under the circle, draw a box around each, and a line from each box to the circle:



In continuation, the following two questions apply to each point selected: 1) what point is it a response to, and 2) what points are responses to it? By asking these questions over and over, one can eventually exhaust all the points of an issue. The final product will be an issue tree which shows all the lines of thought involved in the issue under examination. Note that although most issues seem complex due to the many points and paths of thought they contain, in reality, most issues become fairly simple once their logical structure has been grasped.

Most issues will not be laid out and developed the way in which the Ford Argument was - from top down. The Ford Argument began with a basic point that fit naturally at the top of the tree; most of the points were stated in that argument; and each line of reasoning was developed in a natural sequence (see "Unstated Points", Chapter II and below). In common practice,

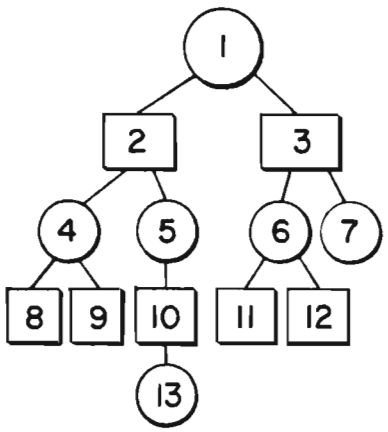
however, people tend to jump from one line of thought to another, which naturally contributes to misunderstandings, (see the discussion of the problem of traversing the tree in Chapter V). In addition, the real issue often does not surface until part way through the reasoning process, which means that one has begun in the middle of the tree and then has worked "backward" up to the top. To aid in the understanding of exactly how the points in an issue can be presented in different ways, two extreme cases will be considered: the case of newspaper reports and the case of the scholarly article.

D. CaseII: Reporters vs. Scholars

An especially complicated way of dissecting an issue occurs in newspaper articles in which the object is to present the points in the order of their importance. A reporter never knows exactly how much of his article will be published, so he must write it so that it can be cut between any two paragraphs and still be considered good. As a result, in the first paragraph, a newspaper article typically states the top point together with a few of the points immediately below it.

In the next paragraph a few moves down from some of the points just mentioned will appear and also, some of the points from the first paragraph will be developed. This process will continue until all or most of the initial points have been covered. By the third, forth, or fifth paragraph, the points introduced in the second paragraph will be continued a few moves downward, and so on. The resulting tree is therefore presented as shown below in Figure 0, where the nodes are numbered in the order presented. Thus, a reporter may place points 1, 2, and 3 in the first paragraph; 4 and 5 in the second, etc.

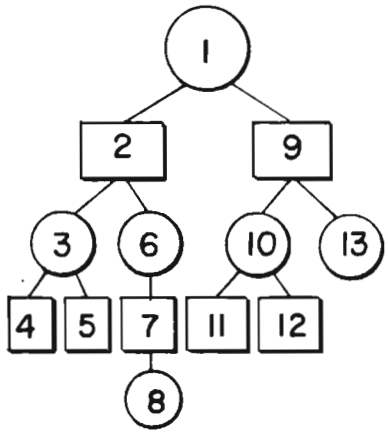
FIGURE O



Basically, the reporter presents the tree a level or two at a time, instead of one line of reasoning at a time, because, in general, the top levels of the tree are more significant to the issue than are the lower levels. Also, at each level there are many more points to be made to cover the whole tree at that level, so that the addition of one more point to each line of reasoning becomes increasingly difficult.

The newspaper style of writing is very different from the style of a book, a thesis, or a scholarly article, so one must consider carefully exactly the type of material with which he is working. Scholarly writing typically proceeds through a number of stages (ie., explaining the problem, indicating what others have done in the field, presenting data, etc.), where each stage is developed in great detail before the next is considered; where each line of reasoning is followed to considerable depth in the tree before another line is begun. In effect, the tree will appear in vertical sections, in contrast to the horizontal sections of the newspaper story. Such a tree is shown in Figure N, below.

FIGURE N



The advantage of this style over the newspaper style consists of the fact that most paragraphs follow logically from the one preceeding, so that a more logical flow of thought exists. The disadvantage consists of the seemingly endless details one must cover before identifying the most significant points. For example, if the article presents two or three hundred points and one only wishes to abstract the most essential thirty or fifty points, much time will be lost in a 'point sorting' process.

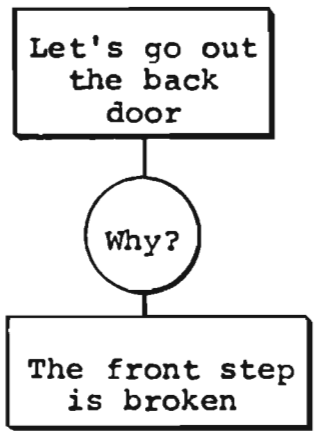
Regardless of the style of writing or speech, there will be a significant amount of 'jumping' within the tree. The failure to recognize the jumps made, constitutes one of the more common errors in tree construction - it cannot be assumed that with any two successive points, the second responds to the first. The complications caused by jumping, for a person performing his own reasoning, shall be termed the traversing problem (Chapter V).

In summary, then, creating a tree from an article or discussion can become complicated, requiring careful thought. Consider that there may be unstated points, and that the reasoning may jump around from one line of thought to another or even begin somewhere in the middle of the tree. With practice, however, proficiency will be developed in grasping the underlying

structure of a complicated piece of reasoning and in building as much of the top of the tree of it as one desires. Constructing issue trees is an art as well as a science, and as with any art, there is no substitute for practice.

E. Unstated Points

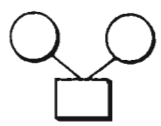
Often a point may be so obvious that it will not be stated. For example, one might say, "Let's go out the back door. The front step is broken." Here the second statement is an explanation of the first, answering the question, "Why go out the back door?". In an issue tree, this question must appear as follows:



(See the discussion of 'unstated points' in Chapter II).

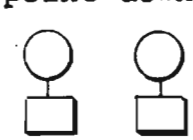
F. Downward Convergence

Never connect one node to two nodes above it



WRONG!

Occasionally a point will appear to be a response to two distinct points. Avoid the temptation to connect them as shown above. Rather, write the point down twice, like this:



If this duplication appears too often, then the points are probably not being correctly grouped - what was in fact the same point, was probably separated into different nodes.

G. Operators

Some short points, frequently omitted are: "Why?", "How so?", "Meaning what?", "So what?", "How do you know?", "Such as?", "Why not?", and "How?"

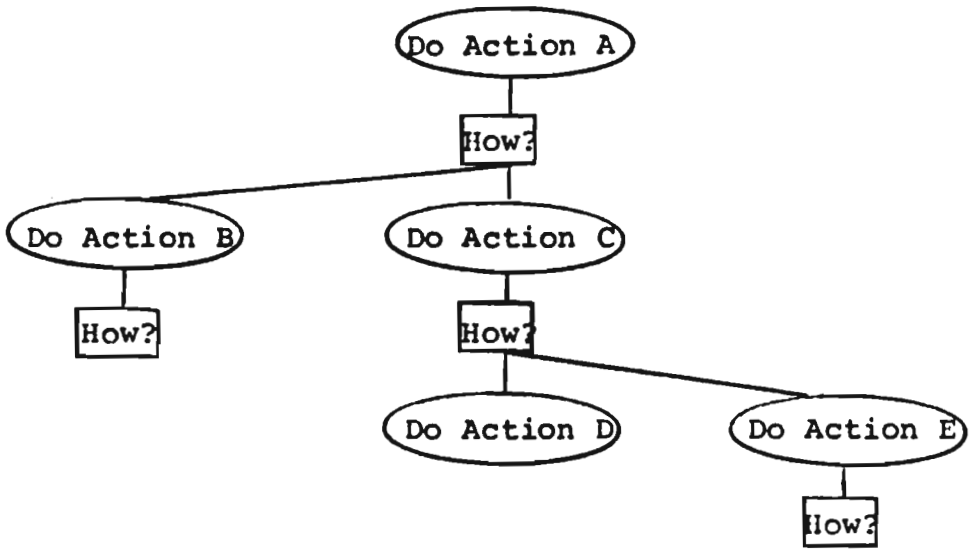
These points are called operators as they tend to operate in a standard or mechanical way in many situations. "Why?", and "How so?" ask for reasons; "Meaning what?" asks for clarification; "So what?" asks for significance; "How do you know?" asks for evidence; "Such as? asks for an example; "Why not?" asks for a reason against; and "How?" asks how.

Omitted operators can cause confusion. For instance, an example is often confused with evidence and vica versa, that is, "Such as?" is often confused with "How do you know?"

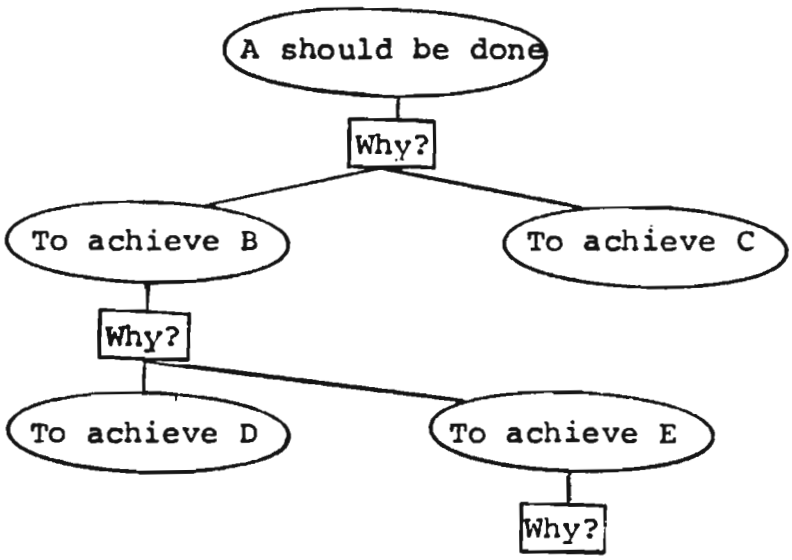
H. Some Simple Kinds Of Trees

Trees do exist which only utilize one or a few kinds of operators, or no operators and just a few basic moves. Many common situations may be represented by such trees.

(1) The How Tree: This tree can be applied to the breakdown of complex activities into progressively finer sub-activities.



(2) The Why Tree:



These trees are 'automatic' in that no choice of operators and moves are made. Children, for example, learn that long chains of reasoning can be generated through the simple repetition of an operator such as "How?" and "Why?". Whereas the 'How Tree' analyzes an activity in terms of its components, the 'Why Tree' examines the reasons for an activity. In fact, most of the operators listed above (See Operators, Chapter III), if used alone, would lead to

some type of specialized analysis. Moreover, each of these specialized patterns of analysis corresponds to a reasoning activity which is common in everyday life. There are times when one just wishes to pursue the "How?", or the "Why?", or the "So what?" of an issue. In such situations, the use of a single operator format would be appropriate.

A little more sophisticated, but basically simple, are the following types of trees:

(3) The 'What Does That Mean?' - 'Such As?' - 'What is Your Evidence?' Tree (MSE-tree)

Using only the operators, "Such as?", "Meaning?", and "What evidence?", and in the absence of objections, one obtains the tree of theory or statement evaluation. This pattern explains and supports an idea, but is not the typical pattern of idea evaluation, for evaluation includes the issue of coherence, or consistency with other beliefs. Coherence, in turn, is usually tested via objections which must be absent in an MSE-tree, as specified above.

(4) The MSE - 'Not So' - 'Why Not?' Tree (MSEO-tree)

This tree diagrams the full pattern of idea evaluation. The operators "Not so" and "Why not?" serve to introduce objections.

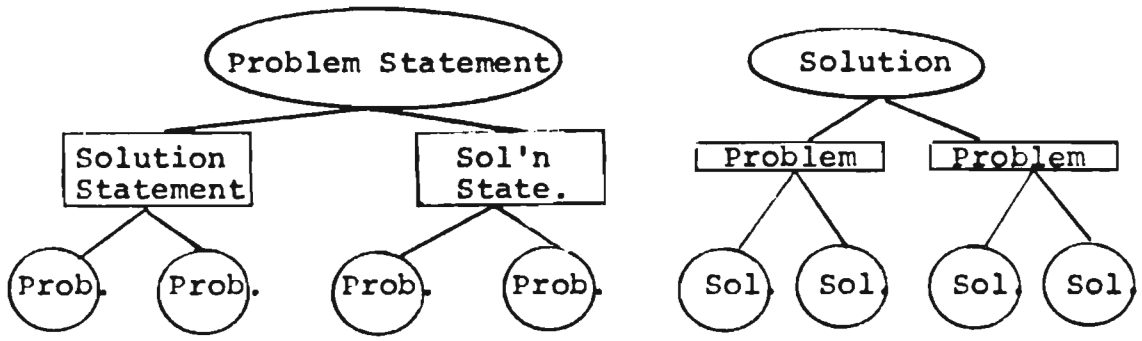
(5) The Simple MS Tree

This trees the pattern of concept explanation (articulation). Concepts can be explained with examples or instances, but not with evidence. Therefore, only "Meaning?" and "Such as?"

operators are required. Observe carefully that the distinction between a concept and a belief often seems to be largely one of degree.

(6) The Problem-Solution Tree (PS-tree)

This tree utilizes no operators, rather it proceeds by the simple alternation of two kinds of moves: (1) the posing of a problem and (2) the offer of a solution to that problem.



I. Hints

1. Trees can vary in degree of detail. One might build a 100 node tree on all the problemsof the world or on how to tie a shoe. In all cases, the proper level of generality must be chosen. As a rule of thumb, however, a tree of 100 nodes can be read in 10 to 15 minutes and equals the content of a typical one hour discussion.
2. What makes a tree good or bad? The most common mistakes committed in building issue trees are: skipping points; putting several points in one node; relating points which are not related; and vagueness. It requires practice to learn to recognize logical responses, though most people learn very quickly with some instruction.

With time and experience, one should be able to write down the tree of a normal pace discussion as quickly as the discussion occurs.

3. How large is an issue? The breadth of an issue depends on the level of detail one chooses. However, we have found that at a reasonable level of specification (ie. similar to that in the Ford Argument), people produce from 50 to 150 points an hour when discussing issues. Most people seem to know at least 2,000 points on a number of different issues. Moreover, a major issue may run to 2,000 or even 10,000 points.

4. Do issue trees generate decisions? Issue trees lay out issues, they do not merge to form decisions. If one must make a decision on an issue, an issue tree should be an aid to grasping what is at stake, but it will not decide. One could attempt to attach weights to each of the points in order to 'model' a decision, but this would be an entirely different matter.

5. How does an issue tree differ from an outline? First, unlike an outline, an issue tree assumes the form of a chart or map, in which points can be beside as well as above and below one another. For this reason, an issue tree can include more information in a given space, which constitutes an important part of its usefulness. Second, there are many ways to write an outline but there exists only one basic issue tree for any given discussion. An issue tree gives the 'natural' structure of a piece of complex reasoning.

6. Can one build an issue tree without having a discussion to work from? Certainly; issue trees can be used two ways: descriptively when used to tree-out a pre-existing discussion or article; and creatively when used to help one think his own way through a problem or idea. One benefit of using a tree in a creative fashion is that it can be put aside and picked up later, with no loss of line of thought. Also in the creative vein, trees can be used to explain very quickly one's reasoning to someone else; trees can be built via mail; and trees can transmit the content of a 'group' discussion without the need of a 'group' gathering.

J. CHAPTER III: Exercises

1. In Chapter I, Exercise 3, you made up discussions of various issues which you then 'treed out' after Chapter II. Pick one of those issues and find enough information on it to build a 50 node tree. How many points are also on your made-up tree? Do you have any that are not on the one you just built? (You might compare with someone else's made-up tree for a more objective look).

2. Expand the tree built for Exercise 1 above, to 150 nodes.

3. Sit down with two or three people, preferably of different backgrounds, professions or ages, and ask them to discuss one of the issues listed in Chapter I, Exercise 3, or choose some other topic that they are likely to know about and disagree upon. Try to draw the tree of their discussion as it proceeds but do not let the participants refer to it. (You may have to ask them to go slowly for you).

4. Do the same as Exercise 3 above, but use a tape recorder so that the participants need not go slowly and do not see the tree.

5. Do the same as for Exercise 3 above, except let the participants use the tree as a reference system. (Let them play too!)

6. Analyze the difference between the trees you got in Exercise 3, 4 and 5 above (3 and 5 might be enough) in terms of:

    a. Amount of branching, especially in the top few levels
    b. Amount of confusion
    c. Typical lengths of lines of thought
    d. Time spent on examples, as opposed to evidence.

7. Build generalized trees of the trees built in Exercises 3, 4, and 5, above.

8. (Coordinated Research Program) Get together with several other people, or even a whole class. Build a small tree on some hot issue; large enough so that there are enough unanswered interesting points for each person to take one (take a small issue or there will be too many). Let each person take one or two points and build a 25 to 50 node tree on each. Assemble these small trees into a large tree of the issue. Repeat as often as you like.

    In this way you can easily build a 500 or even a 5,000 node tree. Moreover, everyone's efforts should fit together without duplication so that each person becomes a kind of expert working on a coordinated research program.

9. (Interdisciplinary Study) Do the same as for Exercise 7 except designate each person as an expert in one or more disciplines. Then, instead of building whole sub-trees, let each person build only those lines of thought that fall within his or her disciplines. Where two disciplines interact, as in the medical effects of nuclear radiation, two experts will have to 'reason out' the relevant lines of thought together.

   You will find that this exercise is a lot tougher than the coordinated research program of Exercise 7, because (1) it calls for a lot more interaction and (2) it is necessary to agree on exactly which discipline governs each point. This is why many interdisciplinary studies end up as coordinated research programs.

10. Pick an issue on which there is widespread disagreement. Find articles representing extreme sides of this issue and tree them out to 50 or 100 nodes separately. Now compare the trees. How muchoverlap is there? Do the facts presented disagree or is it just that different lines of thought are followed? Are there cases where the same basic lines of thought occur in each article, but the authors always stop with a point on their own side?

11. Build a 100 node tree on one of the following topics. Number each node and give a reference for each point made on a separate sheet. Where you made the point, say so, or if a point just seems to be a common belief, put "common belief" as a reference. You may have to do a good bit of research to get good coverage of the issues.

    Topics

    a. Whether 10% inflation is worse than 10% unemployment.
    b. One of your own major personal decisions, such as going into debt, changing vacations, etc.
    c. Whether one should buy a Ford car.
    d. Whether the theory of evolution is true - as discussed in 1970.
    e. Whether the theory of evolution is true - as of today.
    f. The nature of seagulls (or any other object of scientific study).
    g. The problems to be expected if every country gets nuclear weapons, and what can be done to deal with these problems.
    h. Why there is poverty in the United States.
    i. Why there is poverty in the world.
    j. What caused the industrial revolution.

CHAPTER IV: SYSTEMS OF IDEAS AND THEIR ARTICULATION

A. Introduction

With a working understanding of the basic concepts and skills needed to build issue trees, attention should be turned from the simple construction of issue trees to the more challenging task of using issue trees both to aid in understanding others and to aid in being understood. However, the effective use of issue trees will necessitate the consideration of how successful instances of complex reasoning develop, as well as their mere form. For this reason, two more basic concepts need to be introduced, namely that of a System of Ideas, and that of the Articulation of such systems.

B. Systems of Ideas

A system typically consists of a set of things which are related to one another by some function or process. Sociologists, for example, talk about 'kinship systems' wherein all of the family relationships group people into functional units within a society. Also familiar should be the different 'political systems' - the different ways in which people can operate together to form a state. At a simpler, more physical level, there are cooling systems, transportation systems, postal systems, respiratory systems, etc. The central idea in the concept of 'system' is that of units which function together to perform some overall task. What, then, would constitute a 'system of ideas'?

A system of ideas means, simply, a set of related ideas which compose a good piece of complex reasoning. It has already been demonstrated how an issue tree can represent the inter-relationships between the points or ideas in an article or lecture. A well done article or lecture (ie. one in which all of the points made are relevant and useful, and no important lines of thought are left out) creates a System of Ideas.

The tree of a system of ideas demonstrates the inter-relatedness of ideas within the system. This interrelatedness can be recognized by identifying the 'central idea' presented in an article. "Idea", in this context, incorporates a great many ideas which are all interrelated as parts of a piece of complex reasoning, in a complex but functional system.

That a complex idea assumes the same form as a piece of complex reasoning (ie. a tree), becomes evident from the fact that one must reason out such ideas in order to explain or understand them. Indeed, we contend that even concepts have an underlying tree structure, so that acquiring a concept signifies learning to make the moves in some system of ideas appropriate to that concept.

Thus, a system of ideas takes the form of an issue tree which maps out a group of points in such a way that they act together to convey some general point. Moreover, in a complete system, all of the points are relevant and all the relevant points are stated.

The concept of a system of ideas will be very important in what follows, because often the distinction must be made between the tree actually developed in reasoning, and the tree

originally sought. Likewise, in most communication situations, one can distinguish the ideas that people succeed in conveying from those that they wished to convey. In both cases (reasoning and communicating), the goal of a complete system of ideas does not usually materialize both because of missing parts and because of the presence of extraneous material which creates confusion.

The concept of a system of ideas should become clearer upon consideration of actual cases of reasoning and communication. However, inherent in this concept is some irreducible vagueness, as the concept of a system of ideas depends upon the notion of an idea's being relevant to an issue, which in itself is a vague notion. But this vagueness does not effect the usefulness of the concept, for just as some ideas pertain to a particular issue, while others do not, so too will some ideas fit together into a system while others will not.

The ability to make the moves appropriate to the tree of a specific belief or idea composes the criterion for the holding of that belief or idea, and also evidences the fact that a system of ideas or beliefs has an issue tree structure. Moreover, one learns systems of ideas by being taught to reason them out - by learning to traverse the tree of the system.

Certain well-known kinds of belief or idea systems can be distinguished and roughly defined in terms of the kinds of moves or characteristic patterns of moves, which appear in the tree of the system. For example:

(1) A scientific theory, (or factual system), derives its cohesiveness from "What evidence?", "What does that mean?", and "So what?" moves. In these three kinds

of moves, one learns the definitions of basic terms, the laws, what evidence exists, and how the theory applies to the world.

(2) A conceptual system obtains its structure from "What does that mean?", "Such as?", and "So what?" moves. Conceptual systems provide examples, not evidence. (It seems, in fact, that major scientific theories are more similar to conceptual systems than to factual systems.)

(3) A technology, (or pragmatic system), basically consists of "What does that mean?", "How?", and "How do you know?" and "Why?" moves.

(4) A value system is a type of conceptual system which stands in the same relation to a technology as does a major scientific theory to an ordinary factual system. In other words, it bases itself on paradigm examples instead of on evidence: "How?" and "Why?" stay, but "Such as?" replaces "How do you know?".

(5) Policies can be viewed as a kind of technology, except that the ideas involved concern the operating of organizations and institutions, rather than machines.

Note that a distinction must be made between a theory, technology or policy as it exists in literature, and one as it is taught and learned. Evidence, by and large, is not taught, while use and examples are. The evidence exists in the literature, at least in the case of science, but evidence usually only composes an issue (ie. evidence moves are made) in the context of the assessment of new systems - in the context of innovation or revolution

Other important distinctions are: (1) the one between conceptual and non-conceptual or factual levels will be one of degree, and (2) the one between a scientific theory and an ordinary belief system will be only the degree of awareness as to which ideas are held and why. (This, of course, suggests a great difference, but there seems to be no 'scientific method' per se, except the concious allowing of criticism. The tree of a scientific theory dispute looks just like the tree of any factual reasoning.)

Similarly, in the sense of a truly unique way of working out ideas, no such things as an engineering method, a policy-making method, or moral reasoning exist. There are, of course, important differences between these different fields both in subject matter as well as in the kinds of moves that are allowed or that typically occur. Also, unlike the case of science, difficulty often occurs in reconstructing the reasoning that has occurred because the reasoning here is often more intuitive and less easily verbalized than scientific reasoning only because science involves the study of just those things to which our knowledge has advanced to the state of clear, precise description.

Thus, one should find it relatively easy to reconstruct the system of ideas of the theory of evolution or of quantum mechanics, but will find it more difficult to lay out the idea system for, say, an automobile design or federal energy policy. Most difficult of all would be the tree for a conceptual or value system such as for the idea of private property or for the concept of a human being.

It should not be inferred from this that there are not systems of ideas to be found in each of these areas, nor that less reasoning occurs in engineering, in policy making, or in resolving everyday moral issues, than occurs in science.

C. Articualtion

From time to time mention has been made of the development of a given issue (ie. the actual making of moves and points in a tree in some sequence or order). Expressions were used such as 'thinking through' a piece of complex reasoning, 'working out' a complex idea, and 'having' a discussion. A general term for the development of the points in an issue needs to be introduced. This term is "Articulation".

If, for example, one considers how the Ford Argument was articulated by "A" and "B", he would be considering such things as which lines of thought were developed first, how "A" counter-attacked by accusing "B's" son of bad driving, how this point was smashed by "B", etc.

Another example of the difference between articulation and form would be the case of the difference between journalistic and scholarly writing (See Case II, Chapter II). Remember that this difference was explained in terms of two different ways of presenting the same tree: the newspaper writer presents a few levels of the tree at a time while the scholar tends to present complete lines of thought, or 'vertical sections' of the tree. In each case, the tree might be exactly the same, but the sequence in which the points are presented would vary. It can be said that these two styles represent two different ways of

articulating the same tree.

One might, for instance, investigate the way in which political candidates articulate issues both in speeches and in private, or the way in which a friend tends to articulate his ideas when he presents them. What would be examined in the above cases would not be simply the clarity of the ideas presented, but rather the way in which the underlying tree was developed (ie. how the moves are made over time).

In all cases of complex reasoning, an issue tree can be articulated and the way in which it is articulated can be used to analyze how the reasoning was done. In addition, a system of ideas as a special kind of tree (ie. a tree in which all and only relevant ideas are present, down to some level of detail), may also be articulated. Of course, any given tree may be articulated more than once: different people reason in different ways, and even one person may articulate a given piece of reasoning more than once, as in the case of explaining a system of ideas on several occasions.

D. Articulation Analysis Vs. Systems Analysis

To the difference between the form and the articulation of an issue there corresponds two distinct uses of issue trees. One might use trees to aid in understanding a complex issue, such as nuclear safety or abortion; to develop one's ideas for a term paper or thesis; to systematize some body of knowledge, such as what is known about quarks; to solve a complex problem; or to just take notes. In the above uses one principally consults the structure or form of the system of

ideas under consideration.

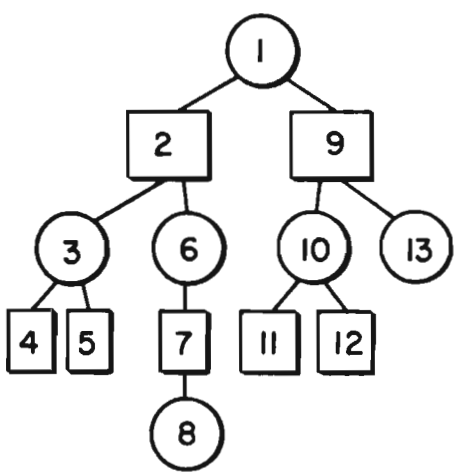
These systems uses differ significantly from using trees to analyze the difference between different styles of writing; to understand how a good trial lawyer presents a case; to diagnose the mistakes one typically makes when reasoning; to investigate the way that small children learn to reason about moral issues; or perhaps even to try to understand how a nation can reason itself into a war. These uses deal with the manner in which systems of idea are developed and presented (ie. with the articulation of some system or other). Thus, in addition to systems analysis, we can use trees for Articulation Analysis - for the investigation of the way in which complex reasoning proceeds or ought to proceed. As presented inlater chapters, a comprehensive issue analysis consists of both a systems analysis and an articulation analysis.

CHAPTER V: THE PROBLEM OF TRAVERSING TREE

Once again, recall the discussion of the difference between newspaper writing and acholarly writing in Chapter III. In newspaper writing a tree was typically presented a few levels at a time so that the more important points were made first (See Figure O, below), while in scholarly writing, whole lines of thought tended to be presented at once so that the logic of the writing flowed smoothly (See Figure N, below). These two styles of writing in fact, represent two extreme ways of solving a basic problem which occurs in all cases of the development or communication of ideas.

To perceive the problem one must realize two facts. First, as the issue tree concept shows, the logical structure of a complex idea (ie. an idea that requires more complex reasoning to be understood), is non-linear. In other words, due to branching, several distinct lines of thought often arise from any one point in the tree. Therefore, and in a perfectly straightforward mathematical sense, most issues involve a non-linear logical space which must be attacked via a sequential progression of points (ie. one point is grasped at a time). As a result, an issue usually cannot be followed by simply following a line of thought, rather jumps from one line of thought to another must repeatedly be made, or elaborate steps taken to retrace. Consider Figure N which schematically pictures a 13 node tree:

FIGURE N



The nodes have been numbered to indicate a sequence by which such a tree might be articulated. Notice that in explaining an idea thusly treed, all the points progress smoothly until point number 4 where the line of thought ends. The next point in sequence would be point 5, but this point does not constitute a response to point 4, but rather responds to point 3 which was made prior to point 4.

This problem might be handled in several ways. First, point 5 could be made with the hope that all listeners grasp the relationship between it and point 3. Since these points follow closely in sequence, a logical jump from point 4 to point 5 might well be acceptable. However, to avoid possible confusion, point 3 could be restated before point 5 is made. Finally, to assure absolute clarity, point 1 could be repeated followed by a complete run through the whole line of thought down to point 5, though this must repetition would be insufferable in most cases. The method adopted depends on circumstances (for example whether one is talking to a person or to a computer); the relative complexity of the points; the importance of understanding; time considerations; etc.

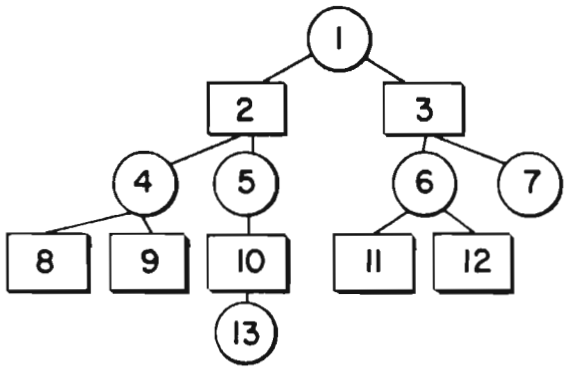
To merely present the points in the order shown in Figure N without 'backing up', how many jumps must be made, and how large are they? Clearly, five jumps occur which equals more than every third point on the average, and which represents quite a bit of jumping.

The size of the jumps depends on the definition of 'bigness' used. Suppose we define the size of a Logical Jump between two points as the number of points on the shortest connected route from the one point to the other. Defined this way, the jump from point 4 to point 5 equals a jump of one point. The other jumps are, respectively, two points from 5 to 6, four

points from 8 to 9, one point from 11 to 12, and two points from 12 to 13. This represents a total of ten points jumped, or an average jump of two points, and is, in fact, the shortest possible route (presumeably mathematically verifiable).

In comparison to the scholarly method of writing as discussed above, newspaper writing contains even more jumping, with larger average jumps since significance rather than logic is the controlling factor. Consider the rather extreme case of newspaper style articulation shown in Figure 0.

FIGURE 0



In this tree a jump occurs every time after point 2 in a path that covers each level before the next level begins. (Remember, in this style each level is more important than the one below it). Calculation shows that upon articulating an idea in this way, 11 jumps are made or, better, one less than the total number of moves, with an average jump of 2.55 points. Notice, in comparison to the scholarly style, the larger size of the average jump. In addition, twice as many jumps occur which probably accounts for the fact that although understandable, newspaper articles seem rather disjointed.

-TRAVERSING PROBLEM DEFINED-

The basic point of this ratherlong excursion into counting and measuring jumps should not be lost. Any time one wishes to develop a complex idea or communicate such an idea to someone else, he faces the

problem of leading his listener or himself through a tree. Usually this means that jumps must be made from one line to thought to another; moreover, these jumps may be frequent and may skip over long logical distances.

The typical tree contains many kinds of moves. To cover a tree points of varying degrees of significance must be made; general points as well as detailed ones must be included; evidence presented; examples offered; questions anticipated; etc. In short, a whole tree of points must be covered. When one adds to this complexity the fact that one must also make numerous logical jumps from one line of thought to another, it is no wonder that issues and communication sometimes become confusing. In fact, the wonder is that people actually do manage to understand and communicate.

What we have discovered is that simply keeping track of all the lines of thought developed, despite the logical jumps made, consitutes one of the basic problems in articulating any complex idea, and shall be called The Problem of Traversing the Tree (the Traversing Problem). The traversing problem occurs in most situations where complex reasoning takes place, no matter if the ideas are being articulated for the first time or simply being communicated to someone new.*

An example of the traversing problem would be the experience of making a decision on a complex issue and of repeatedly examining the sub-issures in search of new angles - without the certainty that all the sub-issues have been covered and without the certainty of how they add up.

In following some public issue (ie. the state of the economy, energy policy, etc.) in the news, on may notice that each news edition states only the most recent occurrences in one small area which causes the overall issue

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*Actually, there are two basic problems in all reasoning - (a) Finding the right tree and (b) traversing it. Given that an issue is a network of ideas, which some trees fit better than others, both (a) and (b) are problems of practical topology.

to become blurred. This type of reacting on a day to day basis, with no real grasp of the way events evolve over time, commonly occurs in society and constitutes still another example of the traversing problem.

A final example of this problem would be that of attempting to explain a 'great idea' to someone else. In this case, one will arrive at points which have several responses. To remember all the responses and eventually cover them may be virtually impossible, as perfect memories do not exist. Clearly, it would not be difficult to confuse or lose one's listener - to get lost in the tree of one's own idea - to fail to make a point due to the traversing problem.

This problem can obviously cause expense and time wasting and probably more bad meetings, bad talks, and poorly solved problems can be attributed to it than to any other single reason. It should be clear by now that issue trees deal with the traversing problem in two ways:

1. they can diagnose it,
2. they can solve it.

APPENDICES

APPENDIX I

CONCERNING TRADE-OFFS AND COMPARISONS

Notes on the Logic of Alternatives

How can the issue tree represent trade-offs or comparisons between various alternatives? Indeed, a good question considering that each alternative would normally be analyzed on its own sub-tree, with no direct comparison to other alternatives.

However, consider the following. Normally, a trade-off represents the sacrifice of the good aspects of one alternative in order to obtain the good aspects of a second alternative. Similarly, a trade-off means the acceptance of the bad aspects of a given alternative in order to obtain its good aspects. (Note: the two are one in the same as the bad aspects are only being accepted if there is some other alternative which does not include these bad aspects). In such a case, one trades-off some of the good aspects of that latter alternative, namely, the avoidance of the bad aspects of the former alternative).

It should be observed, by the way, that each so-called alternative often consists of alternatives, which, in turn, are composed of alternatives and so on. This demonstrates that our normal conception of alternatives and trade-offs is often simplistic. However, one can talk about alternatives at a given level or closely spaced set of levels.

This much said, what about the trees? Under normal circumstances, as we have envisioned them, trade-offs do not appear as points in the tree. What does appear are as many of the good and bad aspects of each alternative as one wishes to or can develop. Once each alternative has been developed, the trade-offs are determined by inspecting the tree. In other words, the tree displays the trade-offs - it does not state them.

However, it would be perfectly possible to have a discussion of the trade-offs themselves which would be a discussion of the points displayed in the tree, and which composes an essential part of planning and practical reasoning. The nature of such a discussion would be normative as the relative values of the alternatives would be examined. In any case, as a discussion, it can be modeled by a tree, but this tree will not be the same sub-tree as the one in which the good and bad aspects of the individual alternatives were developed. The tree which models the discussion of trade-offs could be called a meta-tree for the alternatives tree.

The use of "meta" here corresponds to one distinction made recently by Herb Simon in "Technology and Environment", Management Science, Volume 19, No. 10, June, 1973, between technology and meta-technology. Meta-technology is the art of deciding how to employ technology but while we like this distinction, we believe that the point that each alternative consists of alternatives demonstrates that all technology is in fact meta-technology, thus making the distinction relative to context or purpose.

A typical node "N" of a meta-tree might state that alternative A meant sacrificing good X, which could be obtained by alternative B, but that by using A one got good Y instead, which was better. The discussion in the sub-tree to node N could then take up the issues as to whether X or Y was really better; whether one really got X, or Y; other side effects; etc.

Note that while the sub-tree under N could take up the issue as to whether X really was a consequence of A, this point has presumably already been discussed in the original tree under A. If this does occur, then a major part of the original tree will reappear in the meta-tree, which though not surprising, should probably be avoided. It could also occur the other way, of course, for a discussion of the trade-offs between A and B could probably

occur in the original tree under the discussion of A, as well as under the discussion of B.

The meta-tree merely isolates a part of the original tree for separate examination. Probably this is a good thing to do as otherwise the discussion of trade-offs could intrude so often that the individual alternatives would never develop properly. Methodologically, this means that one first examines the consequences of each alternative and then attempts to assess them by letting them 'come together' in the meta-tree.

APPENDIX II

AN INTRODUCTION TO THE USE OF ISSUE ANALYSIS

What follows is a brief description of a new technique for analyzing complex issues, particularly those issues which involve the evaluation of alternative courses of action. This technique is called "issue analysis". Issue analysis has been developed as a logical instrument to help deal with the complex technological and scientific issues of our day, and in this regard it has both a passive and an active role to play. In its passive role, it is a powerful device for describing, analyzing and understanding the many aspects of a technological, or scientific issue. In its active role, it is a powerful device for describing, analyzing and understanding the many aspects of a technological, or scientific issue. In its active role, it promises to be a useful tool for working through the many factors which must be considered in the planning, design and implementation of new ways of doing things.

The need for a formal procedure for analyzing complex issues, especially those involving new technologies, has become very apparent in the last few years. Virtually all of the public policy debates of recent time involve new technologies in one way or another. Examples of these are the debates over nuclear power, environmental protection, air and water pollution, urban transportation, and space exploration, as well as the whole gammit of reform problems which fall under the loose heading of public protection, such as workers' safety, food and drug policies, product liability, public information and truth in lending. To each of these issues, now several years old, has been added the compelling questions of national energy policy and economic reform, which perhaps exceed all the other combined in their complexity, difficulty, and

farreaching implications. The need for a systematic approach to each of these technological policy issues is widely recognized, and it is now virtually a commonplace that the efforts of many diverse disciplines will be required for their proper resolution. However, while it is recognized on all sides that these issues are both subtle and complex and that many fields of knowledge must be integrated if they are to be resolved, little progress has been made in the actual understanding of the way in which this integration is to be performed. Likewise, while it is generally recognized that technical policy issues involve political, economic, legal, social and ethical factors as well as engineering and scientific factors, there is as yet no way of identifying each of these factors and exhibiting their relationship to one another in the tangled mass of a major issue. This is precisely what issue analysis does. The purpose of issue analysis is to exhibit the complex structure of a technological policy issue, by isolating the many factors in the issue, and by exhibiting the relationship which those factors have to one another. Furthermore, the process of unpacking the internal structure of a technological issue makes possible the organization of that very multi-disciplined attack, which is necessary for the satisfactory resolution of the issue.

The technique of issue analysis depends upon the author's research into the logical form, or structure, of complex problem solving. It is based upon the fundamental fact, which is not widely recognized, that controversies and issues have an internal logical structure. Public controversies, in fact, are often exercises in problem solving. This point can best be made in terms of an example, such as the controversy over the safety of nuclear power generation. This controversy begins when certain objections are made to the existing policy whereby nuclear plants are designed, constructed and

operated. These objections, which we may call first level problems, are relatively few in number and quite general. There are, in fact, only three first-level problems. First, nuclear power plants or their wastes might leak radiation, second, they might be subject to catastrophic accidents; and, third, they are alledged not to be cost-effective. The entire controversy, which has over two thousand significant sub-issues in all, grows from these three stems. Sub-issues begin to arise because there are replies to each of these objections, and objections to replies. To these first-level objections replies are principally of two kinds. First of all, the various studies upon which the existing policy is based may be cited in support of that policy. In addition, the factual basis or support for the first-level problems may be questioned.

Thus, at the end of the first round, when each side has stated its initial position, there are three major objections and attached to each of these objections a number of replies of several kinds. A graphical representation of this state of affairs might show the three major objections contained in three separate circles and beneath these the various replies of the defenders, contained in squares, hanging beneath and connected to their respective objections (see figure 1). At this state, the objectors might introduce another first-level objection, but this is in no way necessary in order for the controversy to develop. All that is required is that the objectors find the responses of the defenders unsatisfactory, for one reason or another. Thus, for example, the objectors may feel that the old studies left out certain important factors, or that they were improperly performed, or that there is now evidence which undercuts their conclusions, etc. Likewise, the objectors may offer their own studies in support of their objections, in response to the defender's objections. In this way, each of

the responses of the defenders to the first-level problems may be objected to in several ways. We may call these objections second-level problems, and we may note that these objections may be in the form of evidence offered as well as in the form of objections to evidence offered by the other side. If we add the points which have now been made by the objectors to our graphical representation we see that each of the squares which symbolizes a reply to the first-level problems of the objectors now has attached to it a number of second-level problems which are designed to respond to those replies (figure 2). Of course, the next thing that will happen is that the defenders will reply to the new round of objections, and these replies will in turn be objected to, and these objections replied to, and so on. In this way, the controversy grows in complexity with more and more points being made by each side with the relevance of each new point to the initial positions of the two sides becoming ever more subtle and intricate (figure 3). But while the issue becomes intricate, it does not become formless. It maintains a heirarchical form.

It is easy to see from what has just been said why technological issues are so complex. It is not unusual for the number of objections and replies which come up in a major issue to reach into the thousands, with dozens of levels.* Moreover, the points which are made at the higher levels cannot be

*The largest issue trees built to date are in the order of five thousand points. These have been for, in one case, a project evaluation, and in another for the public controversy over a proposed urban freeway. Interestingly, the horizontal spread is so fast that even a 2,000 node tree may only have 20 levels. We have also built smaller trees of such things as business conferences, public meetings, and policy debates. In such cases the rate of node production is around 100 per hour. While we are just beginning to draw conclusions, it is clear that when a single attack is made upon a problem, as in a conference or public meeting, there is much less branching than is found when an issue has been around for awhile. Also, the major source of confusion in discussion seems to derive from failure to develop the tree in a systematic way. The basic problem is that while points can only be made sequentially, the tree is a non-linear array. Thus one is forced to skip about. This is where people get lost.

FIGURE 1

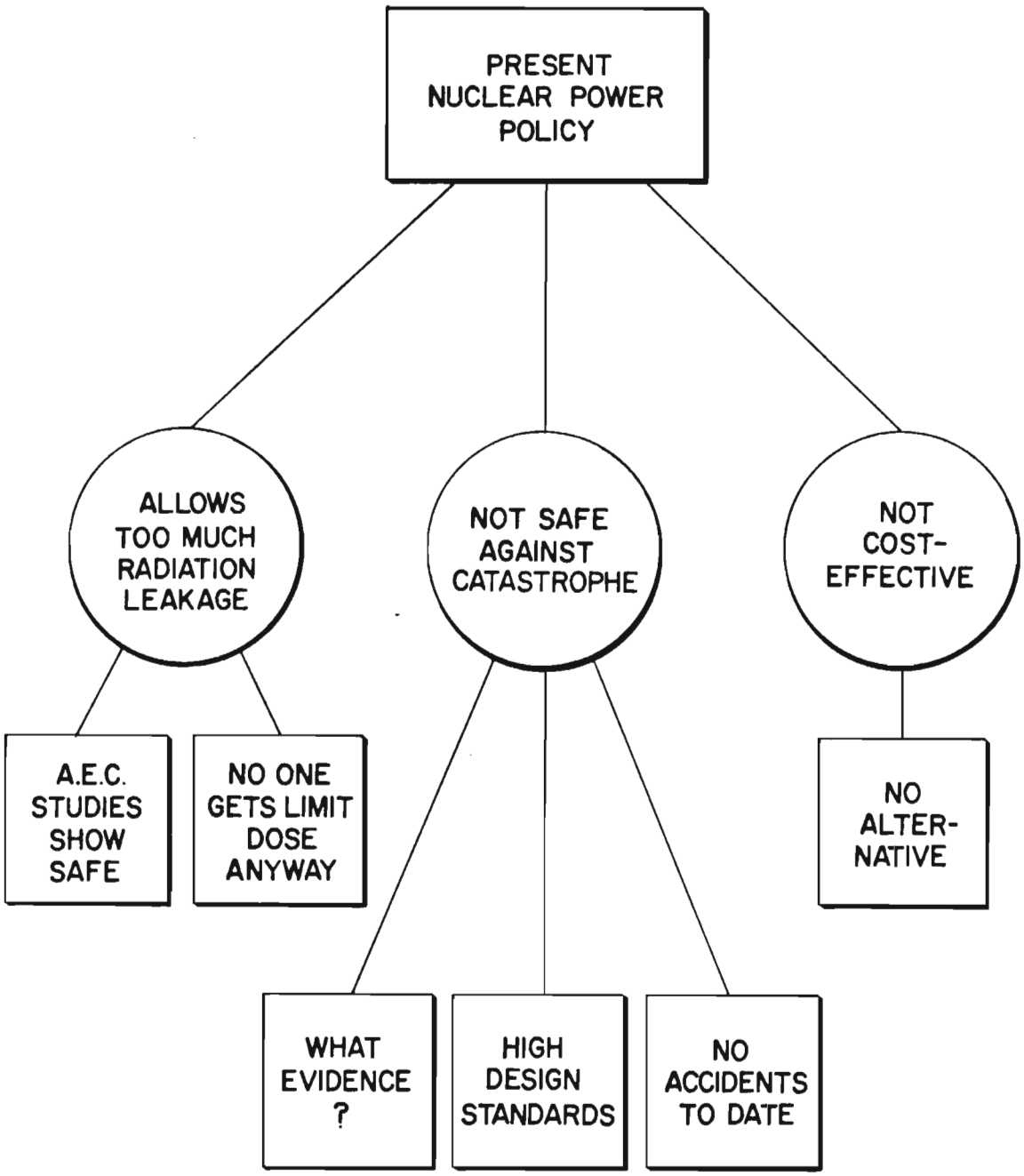
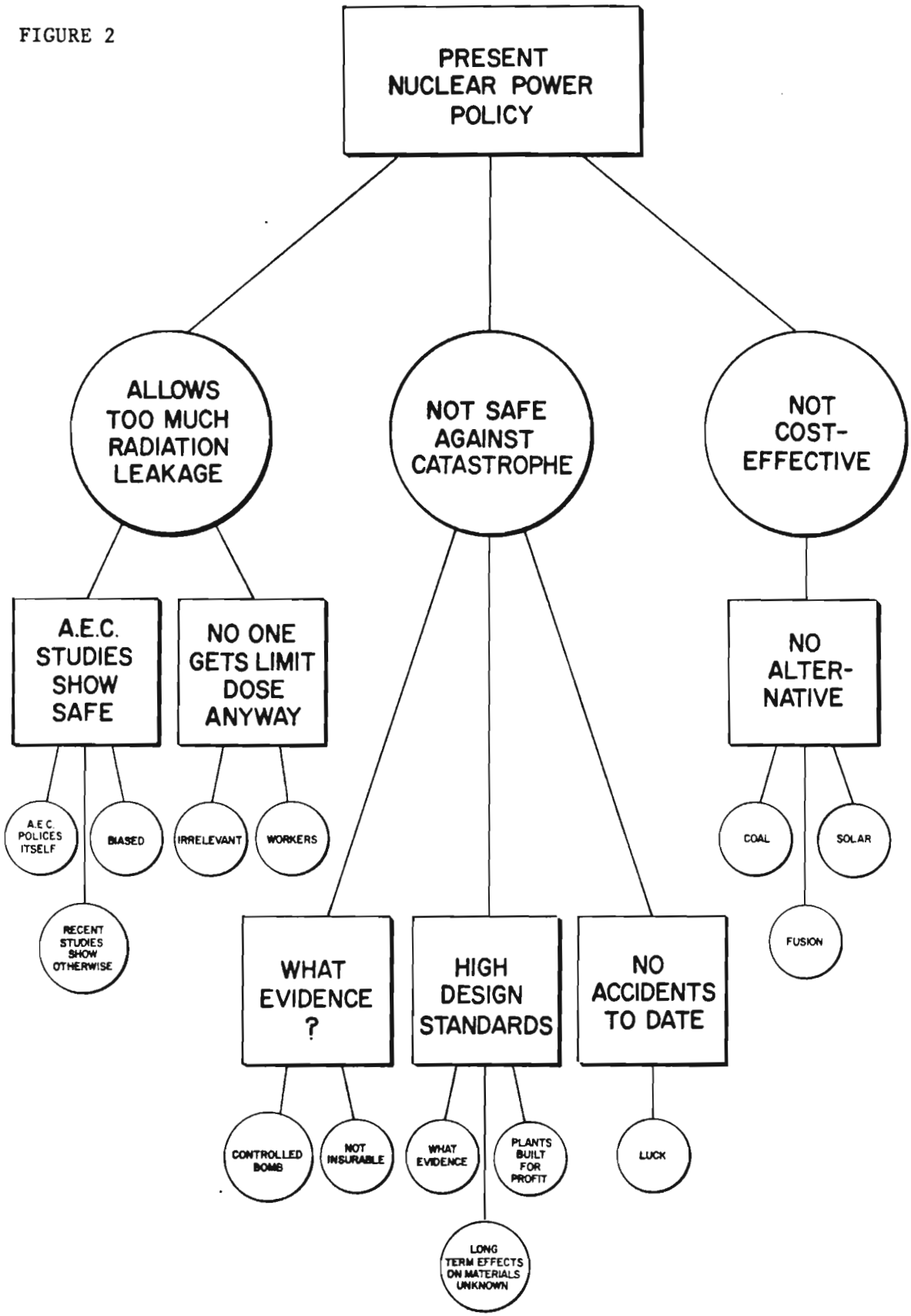

PRESENT NUCLEAR POWER POLICY
ALLOWS TOO MUCH RADIATION LEAKAGE
NOT SAFE AGAINST CATASTROPHE
NOT COST-EFFECTIVE
A.E.C. STUDIES SHOW SAFE
NO ONE GETS LIMIT DOSE ANYWAY
NO ALTER-NATIVE
WHAT EVIDENCE ?
HIGH DESIGN STANDARDS
NO ACCIDENTS TO DATE

FIGURE 2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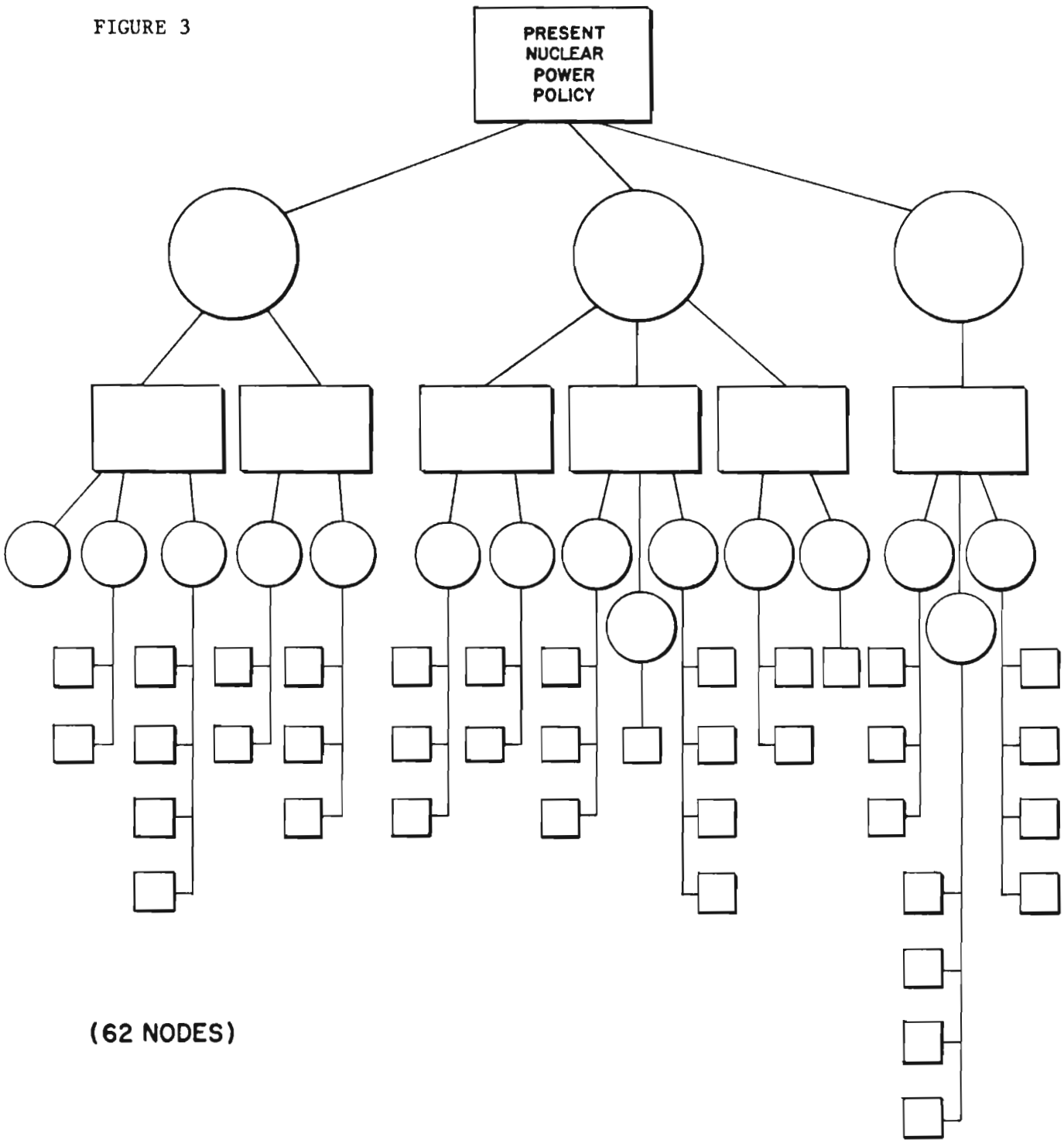
NOT COST-EFFECTIVE
A.E.C. STUDIES SHOW SAFE
NO ONE GETS LIMIT DOSE ANYWAY
NO ALTER-NATIVE
A.E.C. POLICES ITSELF
BIASED
RECENT STUDIES SHOW OTHERWISE
IRRELEVANT
WORKERS
COAL
SOLAR
FUSION
WHAT EVIDENCE ?
HIGH DESIGN STANDARDS
NO ACCIDENTS TO DATE
CONTROLLED BOMB
NOT INSURABLE
WHAT EVIDENCE
PLANTS BUILT FOR PROFIT
LONG TERM EFFECTS ON MATERIALS UNKNOWN
LUCK

FIGURE 3



(62 NODES)

settled until many, if not all, of the lower level decendents of these points have been settled. Also, it is easy to see that there are many, many more of these lower level points, and that this is where the real heart of the controversy must lie. The structure of the controversy which we have just described, is called by mathematicians a tree structure. For this reason, we call the tree representation of the controversy its "issue tree". The technique of issue analysis begins with the working out the issue tree for a given controversy or problem.

The power of issue analysis consists in its ability to graphically represent the many hundreds or thousands of separate points which may be involved in a given issue, and to exhibit the logical relationships which these points have to one another. While issue analysis does not itself resolve issues, it does provide the means for coming to grips with all of the factors which are involved in any major issue. It does this by making visible and ready to hand what has heretofore been hidden, or only intuitively grasped, namely, the hierarchical structure of the controversy. It enables us to talk in a rigorous and detailed way about what has heretofore been only generally describable as 'such and such an issue'. It offers, in short, all of the advantages which the picture of a very complex object offers over a written description of that object.

Issue analysis has application wherever various courses of action are being considered and where a large number of factors are involved in the evaluation of these courses of action. While our example has been stated in terms of a controversy, this is by no means the limit of the method. Controversies, if they are responsibly developed, are merely the working out between a number of parties, with various points of view and items of information, of those steps which any person, be he planner, decision maker, or

just manager must explore when a new course of action is being considered. For this reason, issue analysis offers broad application in the areas of planning and decision making as well as in those areas such as policy science which seek to describe and to understand a passive way the development of those exercises in group evaluation which we call controversies.

In fact, issue analysis has three main areas of use; as a planning tool as a descriptive or analytic tool, and as a teaching tool. As a policy making or planning tool, it may be used to make visible the many problems and considerations which must be considered when alternative courses of action are being examined. The planning process consists essentially of proposing various courses of action designed to meet some problem, then for each possibility, considering the problems which are attendent on this course of action, then developing proposals in turn engender and so on until an over-all conception of the viability of each source of action is attained. The structure of this process is identical with that which we have described for the evolution of a controversy, and it is for this reason that the issue analysis technique is applicable to policy making and planning. The usual problem which confronts the policy maker is that of systematically understanding each of the many sub-problems, sub-sub-problems, and so on, which arise when several courses of action are considered.* By developing the issue tree as the planning process

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*A word about tradeoffs. A common question raised about issue analysis is how tradeoffs-or relations between alternative proposals- are represented in the issue tree. There are two possible answers - first, they often are not shown at all; rather they are seen. That is, the issue tree unfolds and separates out the alternatives (showing, by the way, that every alternative consists itself of alternatives, which in turn consist of alternatives, and so on). The tradeoffs are then seen by examining the tree and seeing what patterns of options, with what attendent consequences, are available. Thus, seeing tradeoffs may be viewed as a synthetic activity which presupposes the analytic activity of issue analysis as its basis. On the other hand, for anything which may be discussed there is an issue tree representation. The fact of a tradeoff may be offered in support of or objection to a given alternative. It thus has a natural place in the tree. In fact, where an actual issue tree is used in a controversy, that tree may well include a discussion of itsel No logical problems seem to arise out of this particular case of selfreference, however.

proceeds, it is possible to systematically keep track of the many considerations which arise and to insure that none of these are forgotten or overlooked. In addition, the development of a full visual representation of the planning process decreases the chances that considerations of major importance will be overlooked.* Moreover, the technique of issue analysis makes it possible to separate out and identify those sub-issues or sub-problems which fall under the special province of some particular person or discipline. This is especially important if we are to avoid a common failing of inter-disciplinary problem solving, namely, that discussion often sinks to the level of common knowledge of the inter-disciplinary group. Likewise, the manager of the inter-disciplinary team may by means of issue analysis readily determine the role which each of the discipline representatives is playing in the formulation of policy.

As an analytic tool, issue analysis should be useful to those who seek to understand the structure and development of controversies, such as historians, social scientists, political scientists, and elected representatives of government.** Other possibilities are lawyers, who might use issue analysis as a technique for keeping track of the evolving disputations of the court, or government agency executives who are involved in implementing controversial

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*We have found issue trees to be very efficient way of conveying information to policy makers. Thus, for example, we developed an issue tree of a public meeting for an urban planning firm. About 75 points were made at that meeting, yet we were able to convey a thorough understanding of all of these to designers who had not attended the meeting in about 5 minutes. There is no magic in this, it is simply due to the human capacity to absorb visual information.

**In this connection we have already used issue analysis to analyze various historical hypotheses as to why a wave of sewer building occurred in the United States in the late nineteenth century. Using an issue tree we were able to develop each hypotheses to the point where tractable sub-issues, evidence for which would tell upon the major issue, could be identified. In a sense this represents the use of issue analysis to plan a research strategy. We are currently exploring the extension of this same technique into the area of technology policy analysis.

policies.

For all of these groups it is to be hoped that the technique of issue analysis will contribute to the better understanding of the decision making process. For example, the form of the issue tree makes it clear why the various parties involved in a controversy cannot readily come to grips with one another's positions. This is so because the relative strengths and weaknesses of various points of view may only be appreciated after considerable development of the structure of the controversy. This seeming difficulty to adequately appreciate alternative points of view has usually been attributed to the narrow-mindedness or bias of people with strong opinions but the issue tree indicates that this difficulty may be as much a function of the complexity of genuine controversy as it is of the closed-mindedness of the participants. Indeed, the issue tree model suggests that the adequate development of alternative points of view requires the conscientious determination to seek to refute one's opponent, for only by this will the full extent and measure of a controversy be developed.*

As a teaching tool, issue analysis offers the means for making clear the full range of considerations which underlie any major decision. The issue tree presents in a simple and straight forward way what may only be with great difficulty presented in the form of written text. The tree-like structure of an

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*This feature of controversy suggests a new approach to the problem of how the evaluation of alternative paradigms occurs. This problem was first raised for philosophers of science by T. S. Kuhn in the Structure of Scientific Revolutions. Chicago, 1962, and it has grown to be a major issue in that field. In fact, I discovered issue analysis while trying to apply Kuhn's conceptual framework to technological controversies (See my paper "The Structure of Technological Revolutions", in the Proceedings of the International Symposium for the History and Philosophy of Technology, Urbana, University of Illinois Press, forthcoming, for discussion of this concept under the name 'evaluation space'). It may be said I believe, that for several years our society has been fairly convulsed by the problem of evaluation of alternative paradigms, and the sooner we can arrive at a satisfactory solution to this problem the better for us all.

issue is not readily presentable in the sequential from of the written word. For this reason, it is very unusual, and exceedingly difficult, to do full justice in print to the many issues which may be present in a major controversy. Yet, it is of the utmost importance that students come to realize the complexity and sublety of realworld decision making. This is particularly true for engineering and science students if they are to develop future technological policies which are both sophisticated and humane.

Several caveats are appropriate at this point, however, for while issue analysis is a powerful tool for decision making, it is no cureall. First of all, issue analysis does not resolve issues, nor does it substitute for the hard work of decision making. Issue analysis is primarily a graphical technique for making visible the underlying structure of a controversy or a problem solving process.* While the value of a visual representation as an aid and guide to the working out of alternatives cannot be underestimated, such a guide is useless without sound judgement. Secondly, issue analysis is not as easy as it may at first appear. Like operations research or computer programming, issue analysis requires a certain talent for understanding the underlying logic of a human activity. While it is true that for any given point in an issue, or for any given proposal in a plan, there are a relatively small number of possible responses, it is yet the case that the proper identification of these responses may be a difficult task. Thus, issue analysis will not make the understanding or resolution of controversies automatic. It should, however, greatly facilitate such activities as complex decision making, policy formulation, and the working out of conflicting points of view, as well as the description or recording of decision making which has already occurred.

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*Though, from the last note at least, it should be clear that issue analysis embodies strong claims about the nature of controversy and decision. It is a graphical technique, but it is not merely so.

Organized Discussion*

Group discussions or meetings constitute an integral part of modern business. A variety of projects, from personnel recruitment to the implementation of new products, demand the platform for discussion and debate of formal meetings. However, two explicit problems in regards to the structure and procedure of meetings have emerged: more than one meeting is usually required before a decision can be formulated and a number of otherwise efficient workers do not function well in the group context of a meeting.

The first problem cited above involves a time-waste factor. Each meeting following the initial one includes a consecutively greater amount of time wasted in the review of what occurred in the previous meeting(s). Due to a strictly human fault - that of the lack of an instantaneous and perfect memory - such review remains necessary although a method of minimizing the time wasted in review should be considered just as necessary.

The conventional method of dealing with the problem of review has been through the use of minutes as an official record of the proceedings of previous meetings. Whether the minutes are read at the beginning of a new meeting, or whether they are distributed to the attendees for review prior to the next meeting, valuable "in-meeting" time must still be devoted to group review and to the arrival at a logical starting point for continued or new discussion.

A new method of recording the proceedings of meetings while minimizing review time centers itself on the use of Issue Analysis. An "issue tree" drawn of the proceedings of a previous meeting, provides a clear and concise visual map of the discussion. The character of a meeting in which issue analysis was thusly employed would be similar to that depicted in the following example:

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*pp. 10-15 Written by F. E. Stanchic

Example:

The topic of discussion in this hypothetical series of meetings concerns the implementation of energy conservation provisions within the corporation. Notes taken during the meetings will be converted into "issue tree" form, and prior to the next meeting each attendee will receive a copy of that tree which will logically map out all relevant dialog on the issue from the beginning to the end of the meeting. As one reads through the tree, questions and/or responses may be formulated and conveniently placed exactly where they relate on the tree.

In the subsequent meeting itself, while each individual possesses his own copy of the tree, the chairman or discussion leader might well choose to refer to that tree on a larger scale such as that provided by a wall chart or transparency on an overhead projector. Consequently, in-meeting discussion can commence immediately where discussion in the last meeting terminated through the simple process of utilizing the bottom node(s) of the "issue tree" as a starting point. Not only does the "issue tree" serve as a template for discussion, but also, the group leader may add points as they are raised, thereby updating the tree as the meeting progresses. In addition, in the interim preceding the subsequent meetings, copies of the tree might be distributed so that each attendee might have the opportunity to make any comments or raise any additional questions. In this manner, the tree, being constantly updated and modified, is kept current while still retaining a detailed description of every meeting.

The second major but common problem with the "meeting" concerns those individuals who do not work efficiently in a group-participation setting. Intimidation with others tends to cause some individuals to remain silent

throughout an entire meeting. However, these same people who fail to respond and produce in a discussion, are often times the ones who contribute greatly in private conversations before or after a meeting. It would seem then that these individuals demonstrate a need for an informal setting in order to perform their best work. Unfortunately, it is in just such informal settings that important points made in conversation stand the risk of being ignored, forgotten or simply stated to the wrong person, which, of course, would represend the loss of potentially valuable input.

Issue Analysis can obviously remedy this situation. An "issue tree", similar to the one described in the previous example, acts as a communication device between a manager and his employees between meetings. An introverted individual who does not function well in meetings, if given a tree of the meeting can add any points he formulates in privacy. These points will either appear at the next meeting where they will be properly addressed, or they might be commented on between meetings assuming the circulation of the updated (modified) tree. Use of "issue trees" insures that each person has an input in the discussion by removing the intimidating elements of a formal meeting.

Methods of Implementing Issue Analysis

If a manager or supervisor were to institute the use of Issue Analysis by utilizing "issue trees" in some phase of the corporate process, a few alternative methods of tree implementation are available. Each mode of "issue tree" application is especially well-suited for a particular usage. For example, using "issue trees" as a communication device, one would be best advised to send a separate tree to each person with whom he may be dealing. By supplying each individual with his own tree, communication is direct and clear. Again, I refer to Example 1, the supervisor would receive a separate and distinct tree from each engineer, this tree would then serve as a direct line of communication between the supervisor and the engineer. In addition, each individual tree could also function as a continuing file on each engineer's project. Therefore, any communiques regarding a particular project could be handled by sending copies of the tree of that project.

If, however, the supervisor or another manager requires a full report on the work in R&D, by simply combining the individual trees under a common top node, he will be provided with a chart indicating lab work in total, while still maintaining sub-trees of the individual efforts of each engineer. By treeing out each project and placing the trees next to one another on a full chart, one can easily detect, for example, duplication of work, or a case of two engineers working at cross-purposes.

Transparencies are another way of utilizing "issue trees". By placing the transparencies of the trees on an over head projector and casting the image on the wall, an entire group of supervisors can be informed simultaneously by tracing their way through the trees. This method is also beneficial when having in-lab staff meetings. Each engineer can comment or offer advice concerning his own or another's work.