This is to certify that the

dissertation entitled

A RECREATION LIABILITY KNOWLEDGE BASED SYSTEM

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Park and Recreation Resources

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Date December 1990

A RECREATION LIABILITY KNOWLEDGE BASED SYSTEM

By

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of

Park and Recreation Resources

1990

ABSTRACT

A RECREATION LIABILITY KNOWLEDGE BASED SYSTEM

By

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Providers of recreation opportunity operate within a legal environment that requires them to consider the safety of participants. Economic and ethical factors also provide incentive for providers to maintain safe land conditions for the recreating public. Negligence law as it pertains to premises liability is the formal body of knowledge that forms the basis for legal decision making therein.

Risk management is a proactive means to limit the potential for injury and subsequent civil remedy. The determination of legal negligence, however, is the final arbitrator in assessing the conduct of a defendant who manages land conditions for recreation activities. Unfortunately, this decision-making process is encountered only when one is named as a defendant in a suit. Thus it is difficult to understand the decision-making process determining negligence without entering the civil law arena.

A knowledge based computer program was constructed to model this decision-making process. Sources of the domain expertise include statutory and civil law, legal publications, and experts within the field of recreation law. The research prototype system strives to assess the existence of landholder negligence as the plaintiff's burden of proof prior to a civil case. Defenses to the assertion of negligence are also assessed. The goal of the research is not the ultimate determination of negligence, but the identification of key issues associated with a case.

Hypothetical case facts were supplied by the domain experts to test the system's ability to identify key issues and estimate the type and degree of negligence present. The outcome was then compared to the expert's assessment of the case.

These tests indicated that the system performed adequately for the stage of research prototype yet remained fragile in the manipulation of legal concepts that have contextual meaning.

The results of this research indicate that knowledge based systems show promise for modeling recreation law. The research also highlighted avenues for improving future systems.

ACKNOWLEDGMENTS

I would like to thank Dr. Lewis Moncrief whose patience and guidance in the role of my major professor has been invaluable. I would also like to acknowledge Dr. James Bristor, Dr. Stephen Harsh, and Dr. Leighton Leighty for their efforts in keeping this project on track.

Dr. Don Holecek of the Michigan Travel, Tourism, and Recreation Resource Center generously provided assistance in the form of use of computer resources. Thanks are also due to Dr. Edward Mahoney for serving as mentor, and funding source, and friend.

Special thanks to my wife Jane who has given me love, sustenance, and a daughter during my graduate studies.

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PROBLEM STATEMENT

Introduction

Liability and insurance issues have impacted many businesses and governments by threatening their feasibility of operation. This threat is often realized in the form of costs of civil litigation and insurance premiums. The recreation industry has become a participant in the increase of liability costs due to the risky nature of many recreation activities that occur within private and public facilities. When a recreation provider becomes a defendant in a liability case, the cost of litigation and potential remedies are incurred. If an operation avoids litigation, costs are still realized in the form of insurance premiums that are based upon the risk of litigation (demonstrated by operators who have been sued). Much concern has been expressed on how these symptoms may impact the recreation in Michigan. The outward costs of liability issues, however, are only manifestations of a complex decision-making process carried out in the formalized arena of civil law. Normally an individual's first exposure to this process is when they are named in a suit. Unfortunately, this exposure comes too late to enable the correction of

situations where negligence may exist. The realm of artificial intelligence, and specifically knowledge based systems, provide a means to model this process and enabling participation in legal decision making without going to court. It is proposed that a knowledge based system be constructed that embodies the domain of negligence law as it pertains to private landholders, facility operations, as well as local, state, and federal levels of government within Michigan.

The Problem

Recreation and tourism has been promoted as a potential element in creating a stable, diversified economy in Michigan. This industry is made up of many independent private and public operators. As liability costs escalate, these operators incur the burden on

1. Direct costs of insurance premiums
2. The threat of civil action by invitees (customers)
3. The potential costs of civil remedies in torts brought against operators (Hronek, 1986).

These elements impact the profitability of individual operations and can even force them out of business (Headrick, 1985). These costs also can prohibit new developments altogether. For the recreation consumer, these elements are manifested as:

1. Limited diversity of recreation opportunity
2. Increase on-site expenses as liability costs are passed on to consumers
3. The creation of an adversarial relationship between recreation providers and consumers

These elements also impact public providers of recreation. The threat of legal liability can also influence the formulation of management objectives and the evolution of recreation and policy (McAvoy, Dustin, Rankin, & Frakt, 1989). For example, in developing a site, a manager must consider long-range maintenance plans as an incurred duty to protect the public. Another element is the duty imposed by implementing admission charges. In sum, the threat of legal liability impacts all levels of operation in both private and public operations.

Another dimension crucial to this problem has to do with organizational ethics. Both common and statutory laws are grounded in social values which are subject to change through time (van der Smissen, 1990). In negligence law, the ethics of relationships is manifest in the concept of duty. The duty one owes to another to protect them from unreasonable risk of injury is ultimately an ethical consideration. The formal rules of law attempt to codify this ethic in a structured format. For purposes of this problem, the legal dimension of

ethics will be isolated from the sociocultural ethic determining acceptable behavior.

The economic, legal, and political dimensions of recreation negligence are based on what society considers ethical. Thus the root of a recreation provider's duty toward the public is primarily an ethical consideration. Quite simply, providing safe land conditions for recreation is the right thing to do.

Much concern is directed toward settlement decisions as the causal element of the so-called "liability crisis." It is the decision-making process, however, that determined these settlements, and thus is the essential element in understanding recreation liability problems. Until recently there has been insufficient methodological basis for conducting research of this decision-making process. Specifically the process that needs evaluation is the step-by-step processes in which legal components are sequentially examined by plaintiffs and defendants' lawyers, as well as judges in the settlement process.

In recreation liability, the realms of nuisance, strict liability in tort, trespass and negligence are applicable. The most common of these torts is negligence (Bronstein, 1985). In the broadest sense, negligence needs to be evaluated in terms of the determination of duty, breach of duty, proximate cause, and demonstration

of damages. Each of these elements are confounded by myriad variations and rules.

The area of risk management has emerged as a proactive means to address negligence issues. To identify and remedy potentially hazardous situations not only aids in reducing injury, but also provides evidence that the organization may use to demonstrate due care exists. Records of maintenance, inspections, and staff credentials demonstrate active concern for the publics served. Risk management not only has legal and economic impact, but also moral and ethical impact (van der Smissen, 1990).

Van der Smissen has extensively detailed the principles of risk management breaking out topics as risk management planning, operations control, and management of financial risks. One common element in risk management is the decision matrix that aids in assessing the frequency and severity of risk potential as illustrated in Figure 1. In risk management planning and operations control, this tool is a valuable means of suggesting the approach to control. The decision matrix is a practical tool based on a qualitative assessment of how the legal system will react to injuries. Thus it is a reflection of probable legal outcomes with little consideration to the legal decision-making process.

SEVERITY	High	Medium	Low
High	Avoid or transfer	Transfer	Transfer
Medium	Transfer	Transfer or Retain	Transfer or Retain
Low	Retain	Retain	Retain

FREQUENCY

Fig. 1. Risk management decision matrix.
Source: van der Smissen, 1990.

There is currently no reliable means for individuals, operators, and agencies to evaluate real and hypothetical potential for legal liability without entering the decision-making process in the civil law arena. The construction of a knowledge based system in this domain would provide a means to simulate this process and, therefore, assist in limiting liability and associated costs.

The domain of recreation liability decision making is both complex and narrow. Thus it is well suited for the imposition of a knowledge based system to evaluate

the elements and factors impacting the decision-making process. It is currently unclear to recreation scholars, administrators, and operators as to which elements of liability law and litigation have, and will impact the operation of a recreation enterprise. The basic modeling of this system would provide a laboratory for:

1. evaluating causal relationships in tort law
2. determining responsibilities of both consumers and providers of recreation
3. predicting how hypothetical changes in law may impact the role of operators, individuals, and agencies

Certainly the discussion of "costs" of recreation liability is important to assess the current operating environment of recreation operators. The underlying problem, however, has not been researched in part due to its being shrouded in nebulous legal idioms and processes. This lack of understanding has resulted in the promotion of "tort reform" to artificially restrain the limits of damages and responsibilities via legislative mandate. This is a top-down approach which ignores the process in which plaintiffs and defendants arrive in court and determine settlements. Basic research is needed to model this process so that it may be understood in empirical terms. Without this empirical knowledge, recreation leaders and operators are forced to

deal with the problem on a symptomatic level without understanding the ontogeny of the liability tort process. Many issues of fact remain unresolved by lack of research (Twardizik, 1985), and finding a means of controlling liability costs is a challenge that must be addressed (Moline, 1985).

A basic model for the legal elements in recreation liability is a first step in understanding the nature of the problem. Specifically, the problem to be addressed is the lack of a formalized methodology to evaluate the dynamic elements of recreation liability within the legal arena.

Potential Uses of the Study

The development of a knowledge based system based on the domain of recreation liability would provide a means to:

1. Identify and structure legal rules and doctrines that determine the inferential processes of litigators
2. Identify elements in the recreation environment that may be controlled to reduce potential liability
3. Model how changes in legal doctrines may change responsibilities of both providers and consumers of recreation

4. Simulate legal decision making enabling out-of-court experience in portions of the litigation process

Objectives

The objectives of this study are as follows:

1. To provide a systematic means of evaluating legal decision making in recreation liability cases. To understand the problem-solving task
2. To construct and evaluate a knowledge based system that is theoretically and practically valid
3. to create extensive explanation facilities in the system to enhance understanding of the problem-solving task by the end users

The Research Document

Chapter II is a literature review that begins with a survey of expert systems research in general. Here pioneering systems from various domains are discussed with respect to the problem at hand. The review then focuses upon the application of expert system methods in the field of natural resources and then recreation. Finally applications and research in the legal domain are reviewed to narrow the focus to areas of specific contribution to this study.

Chapter III provides a broad overview of the expert systems approach to problem-solving tasks. Here the history and basic elements of expert systems are discussed to assist the reader in understanding the vocabulary and conceptual framework of the method. A brief survey of various knowledge representations is included to familiarize the reader with concepts of knowledge engineering.

Chapter IV is a description of methods used to assess a problem for the expert system approach, as well as methods for building the specific system for this research. This is the methods chapter.

The next chapter deals with the evolution for the expert system built for this study (called TOTO). There is a description of the model structure and how the search strategy brings the system to life. There is also a discussion on how difficult problems were approached.

Chapter VI describes the results of TOTO's performance on test cases. The final chapter summarizes the study and discusses the results. Study limitations and avenues for further research follow.

Definition of Terms

Artificial Intelligence Glossary

The following glossary is based in part on Waterman (1986).

Antecedent/Consequent: An if-then rule form where the antecedent is a list of preconditions to the meeting of a conclusion.

Artificial intelligence: A field of computer science focusing on creating intelligent computer programs.

Confidence factor: A numerical value assigned to a fact by the system user to rank confidence to a query.

Domain expert: A person who embodies problem-solving expertise in a domain.

Expert system: A subfield of artificial intelligence that strives to create computer programs that emulate expertise of highly skilled humans.

Fuzzy logic: A means to approximately quantity concepts that are of imprecise meaning.

Heuristic: A rule of thumb used by domain experts in fields where strict procedures are absent or unreliable for problem solving.

Inference engine: The component of an expert system that accesses the problem-solving knowledge and processes the knowledge base to solve problems.

Knowledge base: The component of an expert system that contains domain knowledge.

Lisp: A symbolic programming language favored in the United States.

Metarule: A rule that controls other rules.

Object inheritance. The means in which object oriented programs utilize to describe an object in relationship to attributes shared with others.

Production rule: Rules in the knowledge base that are made up of IF, AND, OD, OR conditions followed by a THEN action.

Prolog: A symbolic programming language favored in Asia and Europe but gaining popularity in the U.S.

Pruning: The expert system process of narrowing the problem-solving task by eliminating branches of knowledge.

Search: Looking through the range of possible solutions to a problem in the attempt to solve it.

Search space: All possible solutions to a problem often narrowed by pruning.

LITERATURE REVIEW

The development of knowledge based systems are a means to extract thorough and detailed information on complex expert decision-making processes with a means to systematically explore and organize that information (Waterman & Peterson, 1985). Current "expert systems" include implementation in the domains of medical diagnosis (Buchanan & Shortliffle, 1984; Clancey & Shortliffe, 1984), mineral exploration (Duda et al., 1979), tactical warfare (Klahr et al., 1985). Other applications include the areas of agriculture, chemistry, computer systems, electronics, engineering, as well as manufacturing and space technology (Waterman, 1986).

Expert system methods have found wide application in the area of natural resource management with a focus on agricultural-related and forestry-related problems. Davis and Clark (1989) and Rauscher and Hacker (1989) have compiled extensive bibliographies of expert system applications for natural resource management problems. The survey of Rauscher and Hacker (1989) demonstrates the breadth of applications in natural resource management on breaks down domain types as follows:

Silviculture/Growth Yield	27%
Fire Management	18%
Pest Management	16%
Soil/Site/Environment	14%
Land Management Planning	12%
Harvesting/Products	7%
Others	6%
	(N = 203)

The category of "others" includes recreation where one system under development is reported. This system developed at Virginia Polytechnical Institute and State University is being developed to predict scenic quality impacts by comparing the relative effectiveness of statistical models in combination with expert system methods (Rauscher & Hacker, 1989).

Harris and Swanson (1990) used knowledge base programming for a resource economics problem involving the contingent valuation method (CVM) for estimating benefits of resource use. The goal of this research is to "increase the validity and reliability of value estimates obtained with the CVM by providing people with the information and structure (i.e., a policy referendum context) necessary for sound CV decision making" (Harris & Swanson, 1990). Essentially, the program acts as a counselor to aid the user in completing a CVM, on screen questionnaire. Cognitive aids (such as graphics) provide

immediate feedback to the user on the consequences of their value judgments. The user may then revise their judgments based on this feedback, thus increasing the validity of estimating benefits where there is cognitive complexity in a decision-making process. The value judgments of the user are subsequently recorded for later analysis.

RANGER is a prototype expert system developed for the United States Department of Agriculture Forest Service intended to aid in marketing efforts by giving expert site selection advice and providing a means of monitoring client characteristics (Forsberg, 1990). In the Forest Service setting, recreational resources are both extensive and diverse. Meeting the specific mix of customer needs to improve satisfaction is problematical because the expertise needed to direct clients to sites is needed in many locations and is scarce. Forest and district level personal have this expertise yet their skills are focused upon operational elements of resource management. Also the peak recreational season coincides with the fire season so experts are often unavailable for consultation. The Recreational Opportunity Guides (ROG) inventories are extensive, yet inefficient or impossible, to use by the public. Most recreation inquiries are handled by receptionists who cannot efficiently sort

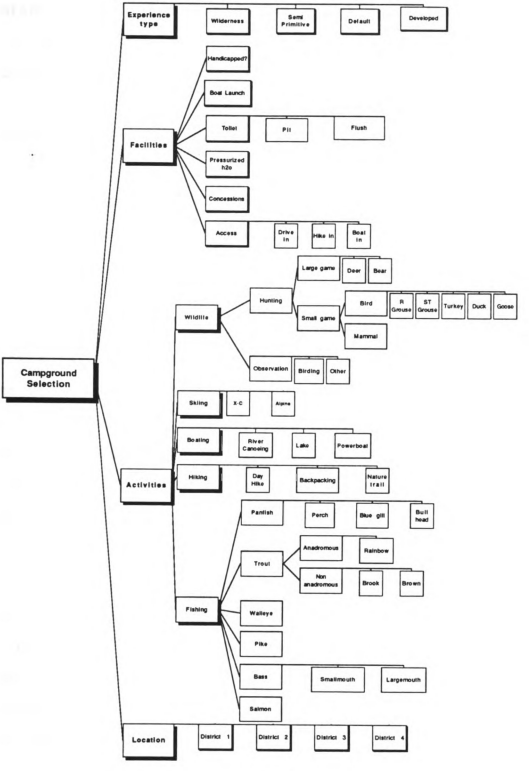
through ROG to arrive at an optimal site to meet the individual's needs.

RANGER is designed to be operated by untrained staff members or the public to match client needs to forest resources. The problem-solving task is diagnostic in nature. The consultation session consists of a series of queries that refine the profile of the user to reflect scenic preferences, facility needs, desired activities, and specific needs such as target fish species. The system subsequently searches the knowledge base (partially based on the ROG catalogue) to match client needs and recommend a site. Figure 2 exemplifies a portion of the search space implemented in RANGER.

The knowledge base is not entirely passive to client needs. The system can be modified to act in a management model to place users in sites that met management objectives. For example, certain sites can be "marketed" while others may be "demarketed." Thus use can be spatially concentrated or dispersed based on management objectives. User profiles also may be used to shift use type. For example, many wilderness users may be more satisfied with simiprimitive resources. RANGER may be modified to identify "fence sitters" and direct them into underutilized sites.

The record of customer profiles provide a market research data base that can be evaluated to assist in

Figure 2. Generalized Decision Tree in RANGER.


Campground Selection
Experience type
Wilderness
Semi Primitive
Default
Developed
Facilities
Handicapped?
Boat Launch
Toilet
Pit
Flush
Pressurized h2o
Concessions
Access
Drive in
Hike in
Boat in
Activities
Wildlife
Hunting
Large game
Deer
Bear
Small game
Bird
R Grouse
ST Grouse
Turkey
Duck
Goose
Mammal
Observation
Birding
Other
Skiing
X-C
Alpine
Boating
River Canoeing
Lake
Powerboat
Hiking
Day Hike
Backpacking
Nature trail
Fishing
Panfish
Perch
Blue gill
Bull head
Trout
Anadromous
Rainbow
Non anadromous
Brook
Brown
Walleye
Pike
Bass
Smallmouth
Largemouth
Salmon
Location
District 1
District 2
District 3
District 4

marketing and planning decision making. Profiles are written into a database which then may be assessed with conventional research methodologies.

One of the early attempts to apply computer technology to the legal domain was in the area of jurimetrics (Gardner, 1987). The basis of jurimetrics was the statistical prediction of judicial behavior without consideration of the decision-making process. Thus it is based on behaviorism rather than cognitive science.

As artificial intelligence methods emerged, legal knowledge based systems arose as research tools in both theoretical and practical realms. Systems developed for practical tasks include drafting legal documents (Sprowl, 1979), drafting statutes (Allen, 1980), drafting estate plans (Michaelson, 1984) and information retrieval (Hafner, 1981).

JUDITH (Popp & Schlink, 1975) was an early attempt to explore legal reasoning in civil law cases. JUDITH was patterned after MYCIN, a pioneering system that attempts to diagnose and treat meningitis infections. JUDITH, however, embodies a knowledge base on the systematic taxonomy of statutory and civil codes. Case law was incorporated into the knowledge base of TAXMAN (McCarty, 1977) to augment general rules of law. A case under scrutiny is described in terms of its divergence

from prototypical cases in memory, via a prototype and deformation model. This model is also capable of representing amorphous concepts or open texture predicates. The plethora of amorphous concepts in legal idioms has been consistently troublesome in representing legal knowledge.

Since civil law is based on case precedents, case based inference has been explored as a methodology. The use of case based inference exclusively has been implemented for predicting judicial behavior without consideration of legal rules and decision-making processes. The information processing task is determining a mathematical or statistical function that "fits" a case to those in memory. It is unclear if this approach can be considered in the realm of artificial intelligence (Gardner, 1987).

The approach of HYPO (Rissland, 1985) avoids the pitfalls of predictive case based programs. HYPO utilizes hypothetical cases used in law teaching to evaluate comparatively a problem case to uncover legal arguments and case strength. A case under consideration is not static; the program modifies it to strengthen elements that may be evaluated in a trail.

Theoretically, case based inference could expand a HYPO type system by evaluating consultations and learning from them. Dolodner (1987) suggests that problem-solving

capabilities may be enhanced by case based inference as in the following:

1. recalling previous mistakes and avoiding them
2. precious decisions can be recalled to limit search space
3. cases can reveal abstract scheme or that can augment general knowledge (Dolodner, 1987).

HYPO has subsequently been modified and refined to utilize actual cases in evaluating trade secret disputes (Ashley & Rissland, 1988).

Meldman's LEGAL ANALYSIS SYSTEM (1975) utilizes both general rules and case information. These two elements are considered secondary and primary sources of authority in decision making. General doctrines are represented as general rules. Rather than matching a case against a body of similar cases, Meldman represented significant cases as specific rules. Key facts of these cases are utilized for explanation of the rules and are not used for inference. By utilizing the holding of a case for the basis of a rule, oversimplification occurs. This method ignores the secondary characteristics of a case that are important justifications for a holding (Gardner, 1987).

LDS (Waterman & Peterson, 1984) evaluates product liability by representing the domain as a body of rules. The weakness of the system is common to many in this domain, representing open texture predicates or amorphous

concepts, such as "ordinary care" or "foreseeability." The authors suggest this problem can be reduced by the following:

1. Provide rules that describes how an imprecise word was used previously in particular contexts

2. Display a brief description of prior use of the term and let the user decide whether or not the term applies in the current instance

3. Ask a series of questions to elicit information about the specific case in which the imprecise term is at issue, compare the answers with prior cases in which the term applied, and provide a numeric rating that indicates the degree of certainty that the rule refining the term applies presently.

4. Use a system of gradual refinement by query to determine whether or not a term applied (Waterman & Peterson, 1984).

Gardner (1983, 1987) has developed a program that evaluates contract law via four levels of processing. The first level embodies knowledge of the ordering of basic legal categories. The second level contains knowledge of the definitions of the major concepts (as if/then rules). The third level of processing contains knowledge about undefined predicates (open texture) in the form of rules and examples. The examples are real and hypothetical cases which are matched to the problem case to fill in gaps discovered by their processing levels. They act as prototype cases to provide meaning individually, or in combination, to an open texture predicate in the run time situation. The fourth, and yet

undeveloped, level of processing will be an attempt to allow and resolve disagreement among experts. Competing examples will be utilized as the basis for this information processing task.

Of particular relevance to this project is the knowledge representation of The Latent Damage System (LDS) by Richard E. Susskind of Ernst and Whinney, UK. The Latent Damage System deals with assessing temporal issues associated with tort, contract, and product liability law. The system was implemented in the rule based Crystal expert system development tool. The Boolean logic and knowledge structure of the Latent Damage System is similar to that proposed in the development of TOTO. This structure consists of rules that are "reverse compound conditional statements" (Susskind, 1989) that have antecedent and consequent clauses. For example, in the rule (IF A and B OR C THEN D), the antecedents are A, B, and C, whereas the consequent is D.

This simple rule structure becomes increasingly complex as consequents become antecedents of other rules. The structure can be represented as an inverted decision tree where conditions must be met to follow a particular branch. The search space is gradually narrowed to focus upon branches that contain specialized knowledge applicable to a particular case.

The major problem associated with LDS is that human judgment is required by the user during the consultation process. Although domain expertise is not required by the user, a degree of logic and common sense is required to interpret queries. This problem is not exclusive to LDS. Within the legal domain concepts gain meaning within case context so that terms such as "reasonable" have variable meaning (these are called "open texture predicates").

Rissland and Shalak (1989) are developing a system that combines traditional rule based reasoning with case based reasoning (CBR) to interpret the meaning of open texture predicates. CABARET initially assesses a case with a rule based reasoner to collect information and narrow the scope of cases to be considered. A control rule activates the case based reasoner and relevant cases are brought under consideration. Various case facts are compared with the problem under consideration to support or reject antecedents. The CBR attempts to match facts of cases in memory to those in the current case . A match may or may not be found. A near miss initiates a search for other cases to satisfy the unsubstantiated conditions. Thus open texture predicates are assigned meaning based on actual case conditions in memory.

Another potential method of dealing with open texture predicates in the use of fuzzy numbers. Coughlan

and Running (1989) utilized fuzzy numbers to quantify symbolic knowledge for a geographical information expert system (GIS). A GIS data base consists of interval data, whereas rules are comprised of symbols. In order to link symbolic meaning to mathematical meaning, fuzzy numbers are assigned to concepts. The problem is summarized as follows:

> If a rule antecedent contains IF ELEVATION IS LOW, how do we numerically define LOW so that we can link it to the data base? Also, what are the boundaries between HIGH and LOW and how are they determined? First, definitions area context sensitive. Assume that HIGH and LOW are contained within the elevation ranges of our study area, 1200 to 3000 m, with 3000 m being a perfect HIGH and 1200 M a perfect LOW. Secondly, inexactness between rule and GIS data can be expressed by a fuzzy function which translates the degree to which a particular GIS variable is represented by a discrete symbolic variable (Coughlan & Running, 1989).

Mapping fuzzy numbers to concepts is a subjective process which posses a problem for application in the legal domain. Cases are not decided on a degree of truth and thus the concept of partial membership is often inapplicable (Gardner, 1987). Fuzzy numbers, however, may be utilized to map the degree of membership of an open texture predicate to the meaning present in the knowledge base. The process remains subjective, yet can be successful if guided by domain expertise. For example, the term "reasonable" can gain specific meaning by balancing the elements of the magnitude of risk with those of the burden of alternative conduct. The set of

variables associated with this balance could be assigned fuzzy numbers. The balancing fuzzy function would then map the domain definition of "reasonable" to that derived in the session context to reveal a degree of membership.

The evaluation of current knowledge based systems reveals several common themes. They include:

1. Problems associated with bringing meaning to open texture predicates
2. The potential for processing problems at various levels of knowledge representation
3. The potential for utilizing examples (i.e., cases, hypothetical or real) at deeper processing levels
4. The allowance for disagreement among experts by utilizing competing examples
5. The lack of explanation facilities as a system component

The Expert System Approach

History of Expert Systems

Since the development of computing machines, there has been an expectation that someday they will be able to reason and make judgments like humans. Hardware and software advanced in the early 1970's created a means to approach the problem of making computers "think." The area of artificial intelligence (AI) emerged in

universities and corporations as a discipline including computer scientists, engineers, and psychologists. By the 1980's expert systems emerged to handle practical problem-solving tasks. Initially work focused on medical diagnostic tasks where extensive bodies of expertise were encased in systems, such as MYCIN. MYCIN was specifically designed to diagnose meningitis infections and recommend microbial therapy (Buchanan & Shortliffe, 1984). Soon expert system applications began to cross disciplinary lines to approach problems classified as follows:

Interpretation	Inferring situation descriptions from sensor data
Prediction	Inferring likely consequences of given situations
Diagnosis	Inferring system malfunctions from observable data
Design	Configuring objects under constraints
Planning	Designing actions
Monitoring	Comparing observations to expected outcomes
Debugging	Prescribing remedies for malfunctions
Repair	Executing plans to administer prescribed remedies
Instruction	Diagnosing, debugging, and repairing student behavior
Control	Governing overall system behavior (Hays-Roth et al., 1985).

Expert systems were initially developed to handle narrowly defined problem-solving tasks. The knowledge bases of these programs were isolated from the inference mechanism resulting in generic system building tools called shells. Expert system shells enable the programmer to focus on developing knowledge structure without actually programming inference strategies. Thus expert systems can more readily be applied to problem-solving tasks within the realities of time and fiscal constraints.

Expert System Components

In their simplest form, expert systems are comprised of a knowledge base and an inference engine. The knowledge base is the symbolic representation of expertise in a given area, and the inference engine is the control or search strategy that brings the knowledge base to life.

A knowledge base is the symbolic representation of expertise gleaned from domain experts. It often contains rules, facts, attributes, and rules of thumb (heuristics) that represent the proficiency of expert problem-solving behavior. The symbolic representation of this expertise may be modeled as semantic networks, frames, and production rules or objects.

Semantic nets represent knowledge as a network of nodes (concepts) linked to each other by relationship describing archs. Frame representations are collections of concepts described by another collection of attributes called slots. Both semantic net and frame representations are hierarchical structures with lower nodes inherenting attributes of higher level nodes. Both of these methods are, therefore, especially suited for representing taxonomies in natural systems.

The production rule is a simple knowledge representation where a decision tree structure is comprised of condition and action statements (Waterman, 1986). Typically, rules are based on IF, AND, OR, THEN, and ELSE statements, followed by clauses. For example, the following production rules determine an appropriate procedure of statistical analysis:

Rule 1

1. IF the criterion variable is scaled intervally
2. OR the criterion variable is scaled ratio
3. AND there is one criterion variable
4. AND there is more than one predictor variables
5. AND the predictor variable is scaled nominally
6. THEN implement ANOVA
7. AND procedure found

This simple structure contains conditions that are possibly unclear. To make the knowledge base usable,

these conditions may be represented in more rules. Condition (1) may be satisfied by firing another rule.

Rule 2

1. IF numbers used to rank items are numerically equidistant
2. AND the zero point and measurement ends are arbitrary
3. THEN the criterion variable is scaled intervally

In order to satisfy the first condition of Rule 1, Rule 2 must first be satisfied. Each condition in each rule may require assessment of additional rules for the rule to "fire." A rule fires when all conditions are met according to Boolean logic. Thus the simple production rule representation becomes an increasingly complex set of interdependent nodes. Typically a knowledge base will contain from 50 to 500 rules.

The inference engine is the control scheme to manipulate the knowledge into producing conclusions. Essentially, it is the problem-solving knowledge used to search the knowledge base. A backward changing inference strategy is initiated by setting a goal for the engine to meet by manipulating the knowledge base. For example if the GOAL "procedure justified" is stated prior to the example knowledge base, a backward search is implemented by the inference engine and the user is queried to meet conditions until the goal is reached. In many bodies of

knowledge, facts cannot be represented with a simple "yes" or "no" queries. In other words, facts are not always true or false in expert problem-solving behavior. Thus certainly factors are often assigned to conditions of rules. Certainty factors are more or less arbitrary values associated with facts. In the preceding rule base, for example, the first conditions of Rule 2 (IF numbers used to rank items are numerical equidistant) may be interpreted differently by a social scientist and a mathematician. The definition of "equidistant" is to some degree viable. To handle this variance, a certainty factor could be assigned by the user to assign a degree of truth to the condition. The user could be asked by the system to rank his/her confidence in the truth of the condition on scale of 0 to 100 or -100 to 100. The addition of certainty factors to rules adds a basis of "fuzzy" thinking often utilized by experts. It is also clear that when a knowledge base has hundreds of rules, these certainty factors add a confounding element in the accurate representation of domain expertise.

A knowledge representation that is gaining prominence is object oriented programming. Objects are entities that are descriptions of chunks of knowledge that contain data, attributes, values, and procedures. Unlike conventional programming structures, objects contain both data and procedures making the approach

suitable for knowledge based programming (Richer, 1889) A group of similar objects comprises a class, which is, in turn, a member of a metaclass. Class variables and methods are inherited to the superclass forming a latus knowledge structure. Object inheritance simplifies the definition of concepts and is illustrated in Figure 3. Object oriented programs are active taxonomies of domain knowledge where objects send messages between one another to perform the problem-solving task. Restructuring our simple rule based representation into classes and objects results in the following (truncated) example.

Metaclass	statistical methods
Class	multivariate methods
variables:	measurement scales
	distribution
	variance
	predictor variables
	criterion variables
Method	perform procedure
Sub class	ANOVA
variables:	criterion variables--1
	predictor variables--1+
	measurement scales criterion--interval+
	measurement scales predictor--nominal
Method	perform procedure ANOVA
	display results
Object	interval measurement scale
Obj. variables	zero and end--arbitrary
	number ranks--equidistant

Neural Networks

A method that has been gaining prominence in the realm of artificial intelligence is that of neural

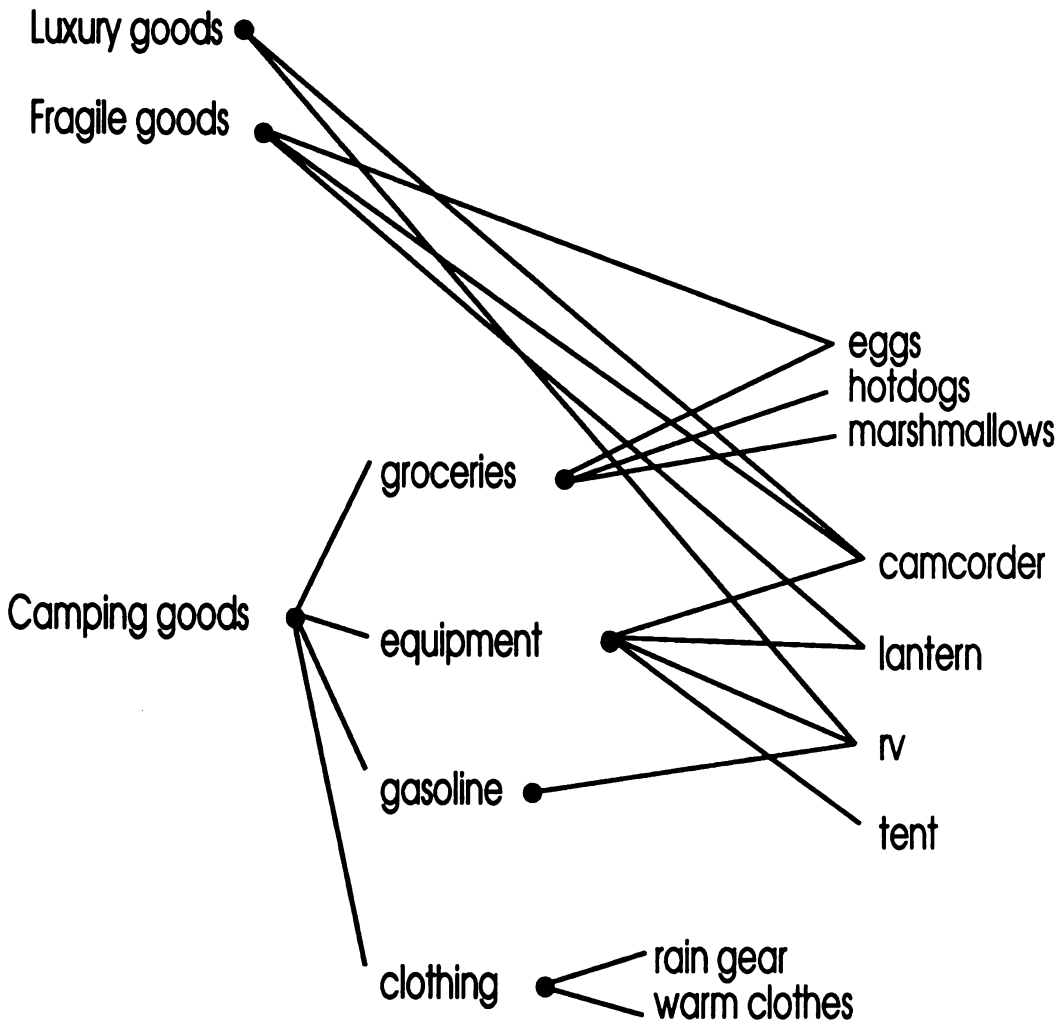


Figure 3. An Illustration of Object Inheritance.

networks. Neural networks are hardware or software simulations of neurological models made up of many highly interconnected processing elements called neurodes (Trelease, 1988) Neural networks do not execute like conventional programs, but rather, react to inputs. Neural networks learn by self-organization. Training paradigms are specified by the programmer to handle various learning tasks.

The network in Figure 4 illustrates the architecture of a simplified "hidden layer" configuration. The input layer represents the data which the hidden layer will respond to. The output layer is the function or vector that is gleaned from the data set. The network responds to the data set stimulus and self-organizes into weighted neurodes (Caudill, 1987). An activation function then determined the level of excitement associated with the neurode. In the basic "backpropogation" training paradigm, the error between the desired and actual output (in the least squares sense) is cycled back to adjust the connections between neurodes (Josin, 1988). The data set is iterated between layers of the network eventually reaching equilibrium. This state is then frozen to represent a state of "knowledge." Learning paradigms are inherently statistically based (White, 1989). As a new statistical modeling technique it is unclear how neural networks will impact recreation research. Potential

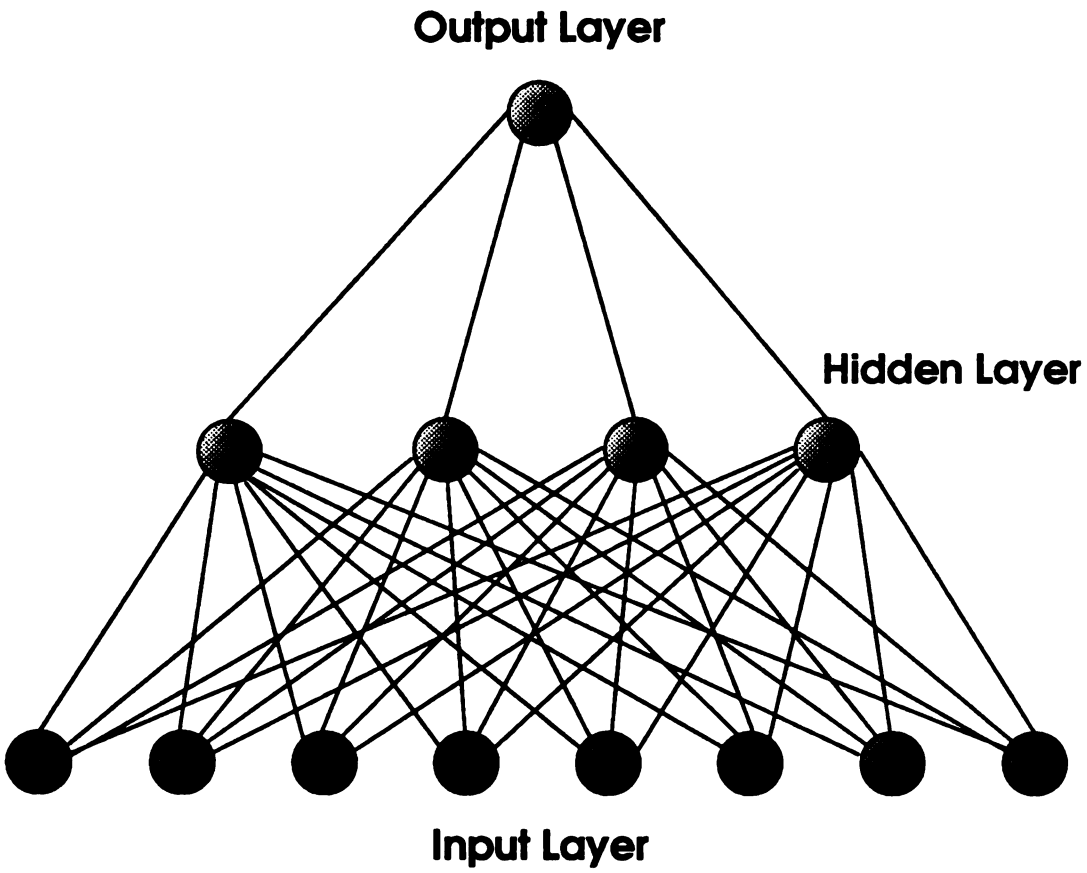


Figure 4. Architecture of a Hidden Layer Neural Network.

applications include networks that provide alternative means of approaching forecasting and modeling problems. Neural networks also show promise in adding in the development of adaptive expert systems that respond to large dynamic data sets.

The expert system approach has been utilized for a variety of problem-solving tasks. There are a variety of ways to represent knowledge and it is the job of the system developer to select the one which best suits characteristics of the domain. As this technology progresses, traditional knowledge representations will be refined while new ones are developed to handle domain-specific tasks.

THE STUDY

Expert System Applicability

The question of the applicability of a system's approach is similar to that of assessing the range of traditional research methods. Traditional methods include experimental survey and qualitative designs. The expert system's approach to a problem embodies elements of each of these designs and can be basic or applied in nature. Basic research in expert systems involves the area of cognitive psychology where the focus is on discovering elements of expert cognition in problem solving. Proponents of this approach insist that until we understand human cognition, one cannot successfully develop valid expert systems. The applied approach is not directly concerned with cognitive processes, but rather, it is results-oriented and pursues developing working systems by utilizing existing technology. This study is more applied than theoretical in nature.

Expert System Suitability

Not all problem-solving tasks are suitable for application of the expert system approach. The domain characteristics necessary for system development are illustrated in Figure 5 (based on Waterman, 1986).

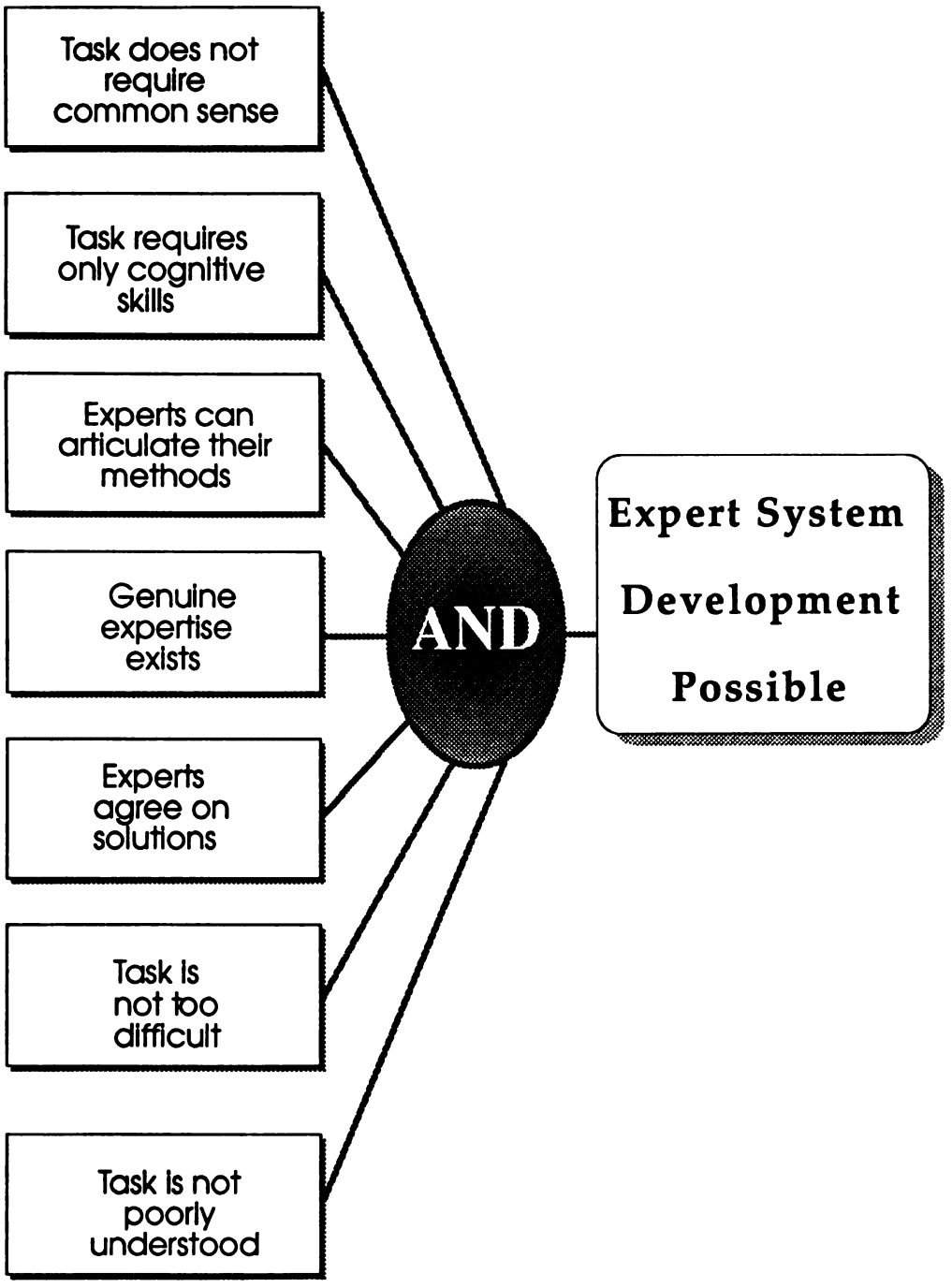


Figure 5. Domain Characteristics Necessary for Expert System Development.

The domain of legal decision making is constructed of a body of common sense reasoning. Civil law is a dynamic, precedent-based process that follows legal principles developed over many years. The domain is not too difficult, nor is it poorly understood and thus is moderately well structured. Expertise in recreation negligence law exists and experts can articulate the methods of legal decision making. A problem arises, however, in that experts do not always articulate their actual cognitive processes and rely upon expected or learned methods when reporting them. The process of knowledge engineering is the methodology of extracting heuristics from experts and other reliable sources.

The fifth characteristic (in Figure 5) of experts agreeing upon solutions is also problematical. In the civil law arena, legal decisions are ultimately decided by jury. There is great variability on how any jury would respond to any case. This final decision, however, is not the focus of the current problem-solving task. The focus here is upon the decision-making process to determine negligence as a prerequisite to a civil case. Here experts in general agree upon solutions where the decision-making process is formalized.

In summary, at this preliminary stage, this domain meets the basic requirements for expert system development as stated by Waterman (1986).

Expert System Justification

Figure 6 lists five characteristics which Waterman (1986) suggests for justifying expert system development. Providing a means for recreation operators to assess potential legal liability outside of court has a high payoff for both operators and users. Operators with such a system may identify elements in their environments that contribute or diminish liability and thus offering a means to reduce the potential for injury. Recreators would receive a payoff in safe conditions in the recreational environment (ethical economic and political benefits). In both cases, the payoff is great in terms of reducing personal injury and subsequent settlement and insurance costs.

This domain satisfies both characteristics three and four as well. Michigan has a great diversity of recreation opportunity provided by both the public and private sectors. If each operator had a legal consultant to assess liability issues, there could be no justification to construct an expert system. This is not the case, however, and it is clear that expertise is scarce and needed in many locations.

Expert System Appropriateness

The expert system approach is appropriate if it fulfills certain intrinsic qualities (Figure 7)

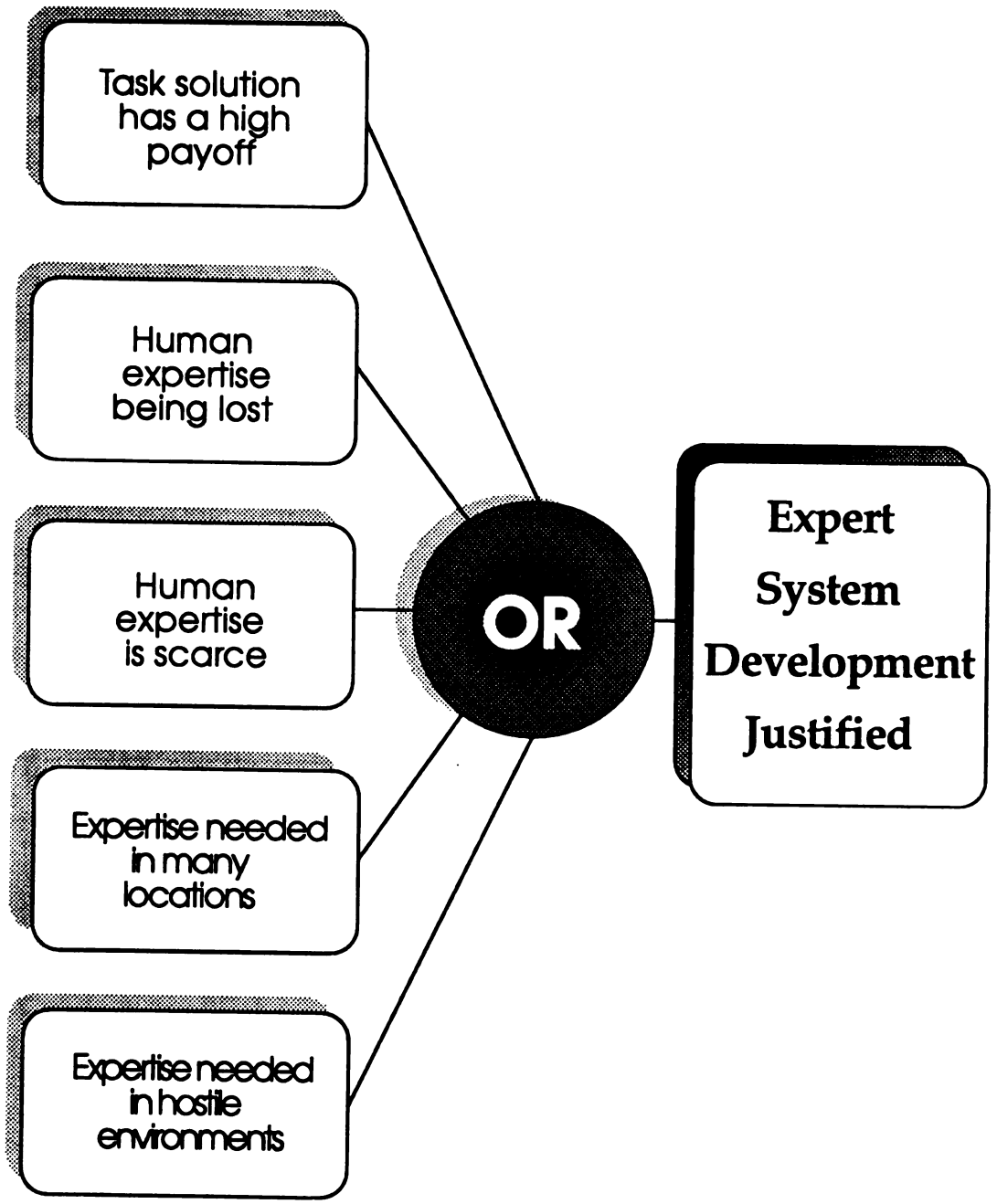


Figure 6. Factors Justifying Expert System Development.

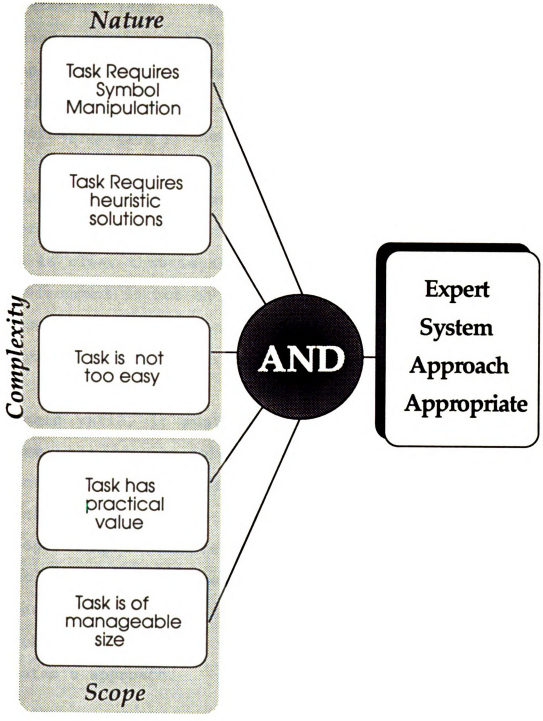


Figure 7. Characteristics Making Expert System Development Appropriate.

(Waterman, 1986). Legal knowledge and decision making is based on manipulation of symbols. Concepts are represented by a string of characters of words and are combined with rules of thumb or heuristics to form the problem-solving process.

Characteristics three and four are complementary in that if the task were easy, there would be little practicality in developing an expert system to handle it. It is clear that legal decision making in the recreation environment is not an easy task. The practicality of the task is readily demonstrated by reviewing the costs of physical injury and settlement processes.

In order for an expert system to be developed and remain valid, it must be of manageable size. In this case, the problem-solving task is limited to assessing recreation liability for any landholder in the State of Michigan, excluding liability incurred by recreation programming. It is also limited in depth to the decision-making processes prior to actual trial. These constraints are necessary to delimit the site of the problem so that it may be addressed with an expert system's approach.

Tool Selection

There are many tools available to assist one in developing expert systems. High level programming languages, such as Lisp and Prolog are used to develop

systems from the ground up. Currently, however, there are packaged tools available for knowledge engineering called "shells." Shells offer a variety of knowledge representations and problem-solving control strategies. Other components of shells include various types of user interfaces, explanation facilities, ability to access other programs, and certainty factors.

The most important element in tool selection is the matching of domain characteristics to a particular knowledge representation. Here the system developer should have a firm grasp of the range of representations and a conceptual model of domain fundamentals. The knowledge engineering environment of the tool should be able to provide explanations of queries. The shell also should embody a means to process fuzzy knowledge or handle degrees of certainty in answering individual queries to the user.

System Building

There are a variety of methodologies for developing expert systems. Weilinga and Bredeweg (1989) classify these methodologies into those that involve rapid prototyping, software engineering, or life cycle models. The life cycle modeling approach that is most broadly recognized is that of Hayes-Roth et al. (1983). This approach is illustrated in Figure 8.

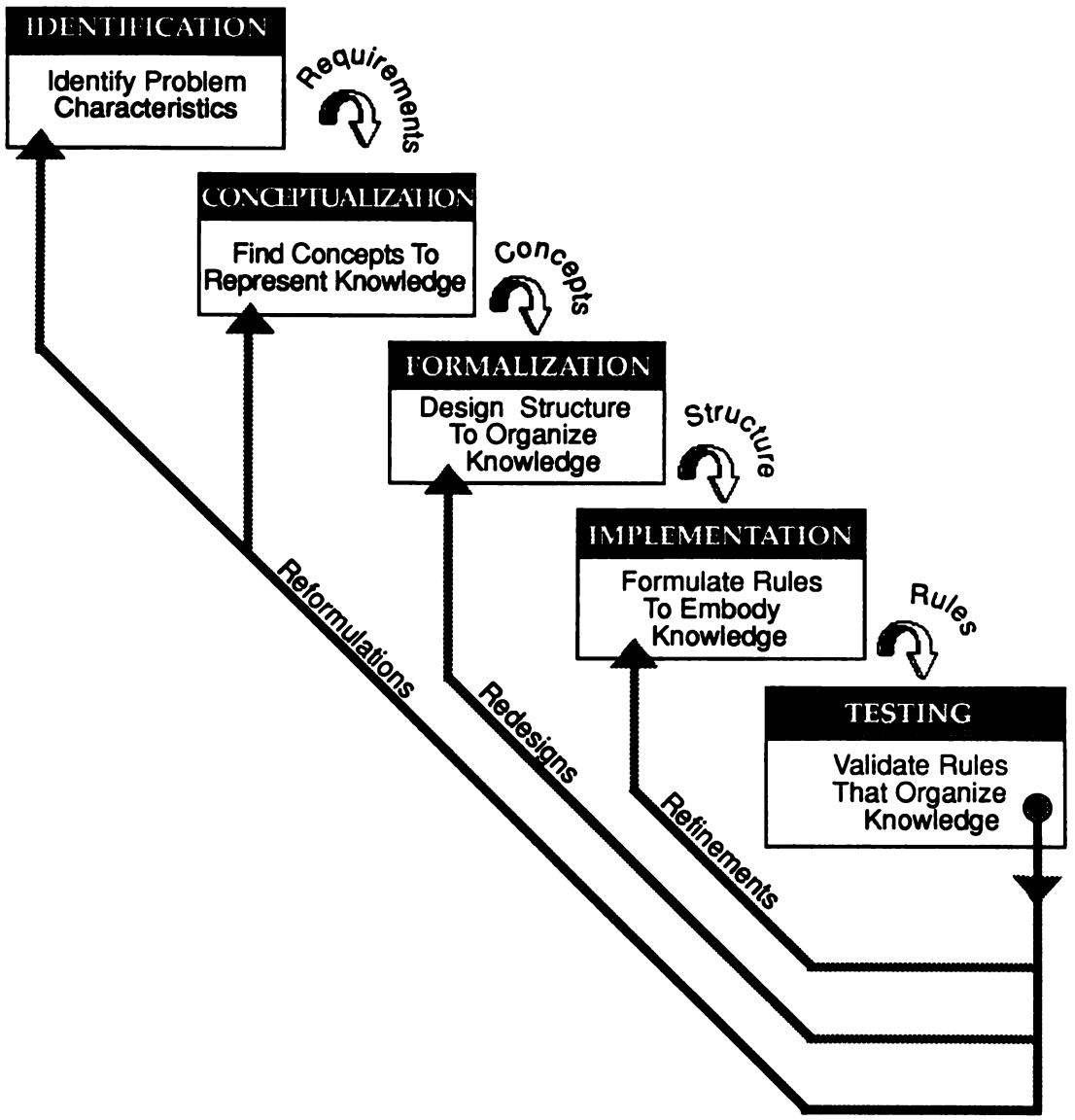


Figure 8. The Hays-Roth et al. Life Cycle Model for Expert System Development.

The identification phase can be summarized by the steps of identifying the participants, the problem, the resources, and the goals of the system. The concepts discovered in the identification phase will be refined and embellished to provide a means to diagram the task with relationships made explicit. This is the conceptualization phase which may involve domain experts, written materials, and other reliable sources of knowledge.

Generally, the formalization phase involves imposing the conceptualizations and relationships discovered in the conceptualization phase onto the specific knowledge representation and control structure provided by the development tool shell. Specifically, this step involves determining the hypothesis space including developing specific hypothesis for the problem-solving task, and determining the granularity of concepts and structure. Granularity refers to the size or level of detail of elements to form meaningful aggregates or "chunks" of knowledge.

Another element in the formalization process includes determining the underlying behavioral model that will impose logic upon concepts and relationships. Also, one must determine a means to deal with uncertainty in the model, and identify hard and soft data. Hard data

include reliable prima facie elements, whereas soft data refer to less reliable, nebulous concepts.

The implementation phase is the actual programming of the system in the programming environment. Here a prototype of the system is developed based on information gained from the previous phases.

Testing of the prototype consists of consulting the system to discover weaknesses in its problem-solving behavior. This not only includes testing the accurateness of diagnostics, but also includes reviewing the representatives and clarity of queries to the user to evaluate if questions are answered in the intended way. The testing process again involves domain experts to aid in evaluating the validity of conclusions drawn from specific case elements. Testing leads to revision of the system to improve its performance.

It must be emphasized that each phase in constructing the expert system creates a feedback loop to earlier phases to refine the model. This evolutionary process is essential in maintaining proper focus and direction in approaching the problem-solving task.

Knowledge Acquisition

The sources for domain knowledge for this project include legal textbooks, legislation, recreation negligence cases, and domain experts. The framework of

the model is based upon rules of law that pertain to negligence torts in general. Pertinent public acts were utilized to bring the general rules of law into the reality of the legal environment of Michigan. Case law was utilized to bring the model into the current status in the civil arena. Domain experts were used as consultants to validify and reject model components.

The knowledge acquisition and system building methodology generally follows the life cycle model of Hays-Roth et al. (1983) as in Figure 8. The problem of recreation negligence is broad and initially had to be narrowed into a manageable size. The problem was narrowed by focusing upon the legal environment of Michigan, and specifically, premises liability. Eliminating other types of negligence, such as personal and programming liability made the problem of manageable size. In the identification phase, problem characteristics were identified which, in turn, provided a basis for disclosing requirements for the conceptualization phase. Problem conceptualization included finding the key concepts to represent knowledge. Here the basic legal and recreation concepts arose primarily from secondary authoritative written materials.

These concepts were then organized into a formalized structure and the basic model called TOTO was created. This process involved the creation of extensive graphic

charts displaying relationships among the concepts. Charting disclosed that the initial problem conceptualization was again too broad. For example, it was hoped that the system could embody extensive knowledge of safety standards for various recreation activities. Incorporating this knowledge would broaden the problem to unmanageable size and also such standards are not clearly defined for many activities. Thus a generic standards model was proposed to assess this element in the more general sense. The knowledge base was also focused on issues pertaining to a limited period in the legal decision-making process.

TOTO focuses on the evaluation process conducted by attorneys to demonstrate that negligence exists. In order for a case to go to trial, a judge must weigh evidence to determine that there is grounds for negligence. The elements of duty, causal connection, and injury must be present for negligence to exist. TOTO is based on these elements as well as an assessment of defenses available to the defendant. By limiting the scope of the problem to pretrial phases of decision making the knowledge base is narrowed to a manageable size.

Formalization provided the basic structure the rule base should follow. During implementation the rules were written to embody the concepts and relationships in

recreation negligence decision making. The rules serve many functions beyond representing the actual knowledge. Rules also provide a means to gather factual information from the user to initially classify the case at hand and narrow the range of problems to be considered. Some rules are classified as METARULES which provide guidance over the problem-solving task. METARULES also compartmentalize subproblems into individually executable tasks. This structure simplifies problem solving by searching only relevant rule sets thus increasing the speed of computation during system consultation.

The formalization phase disclosed potential problems with the model as conceptualized. A simple rule structure was found adequate to handle straightforward legal problems. Many processes in legal decision making, however, are not readily structured into rule sets. Specifically, the determination of "reasonable" and "willful and wanton" conduct in assessing a case emerged as a major difficulty. These open texture predicates warranted a more sophisticated scheme to make them workable in the knowledge base. The approach to this problem will be discussed in detail in the next section.

IMPLEMENTATION

The Knowledge Base

Liability in recreation is based on civil law (as opposed to criminal law), and specifically the law of torts. Negligence torts are common law remedies in which the plaintiff pursues a claim based on injuries sustained by the lack of care of the defendant (Prosser, 1984). The burden of proof in asserting negligence falls on the plaintiff to demonstrate liability on the part of an individual or public agency landowner. In order for a suit to proceed, the plaintiff must allege that the basic elements of negligence are present. Generally, the elements in demonstrating negligence include:

1. There is duty of the defendant owed to the plaintiff to provide a standard of care
2. There is a breach of duty in applying the standard of care
3. There is proximate cause linking the breach of duty to an injury
4. There are actual damages to person or property

Assuming these elements are demonstrated, the plaintiff incurs the burden of proof in the civil suit to

provide the claim based on evidence. The preponderance of evidence falls in favor of the plaintiff if the facts, more likely than not, support the assertion of negligence. This preponderance of evidence is contrasted with the burden of proof required in criminal cases where one must demonstrate fault beyond a reasonable doubt (Kaiser, 1986).

Returning to the element of duty, there are various levels of care owned to the relationships between plaintiff and defendant. Historically, those relationships have been defined as:

1. Invitee: A person is expressly invited onto a premises and pays a fee to enter, or for an activity therein. This may be considered a business relationship.

2. Licensee: A person has access to a premises yet does not pay to enter. This could be a person hunting or skiing on one's property or simply an individual entering a business to use a telephone.

3. Trespasser: The direct physical, unauthorized invasion of the exclusivity of one's property rights (Shulman, 1984).

For each relationship, the landowner is liable for gross negligence, and willful wanton misconduct leading to injury. Generally, this is the only liability a trespasser can claim. An invitee is owed the highest level of care where liability reaches beyond willful wanton misconduct to the ordinary care of premises. The status of licensee falls between the two extremes where ordinary and gross negligence may be considered.

The person pursuing recreation activities on public or private lands who has not reached the status of the invitee has historically been able to sue for ordinary negligence. This has had the effect of discouraging recreation use of private lands. This effect has become troublesome since there is considerable demand for recreation resources beyond which public entities can supply (Holecek & Westfall, 1977). Recreation use statutes were subsequently initiated to limit a landowners' liability in allowing the public to use private lands free of charge. In 1965 the Council of State governments published a model recreation use statute which subsequently formed the basis for legislation in forty-nine state jurisdictions (Kozlowski, 1986). The Michigan Statute reads as follows:

> No cause of action shall arise for injuries to any person who is on the lands of another without paying to such other person a valuable consideration for the purpose of fishing, hunting, trapping, camping, hiking, sightseeing, motorcycling, snowmobiling or any other outdoor recreational use, with or without permission, against the owner, tenant, and lessee of said premises unless injuries were caused by the gross negligence or willful and wanton misconduct of the owner, tenant, or leases (Mich. Stat. Ann. at 13.1485, 1987).

Recreation use statutes are intended to change the level of negligence liability that a private landowner is responsible for. This legislation changes the landowner's standard of care from ordinary negligence to gross negligence or willful and wanton misconduct. Thus

the landowner owes no duty to warn recreational users of known or discovered hazards on one's premises The desired effect of this action is to discourage negligence suits by increasing the criteria in the burden of proof in proceeding with a claim The enactment of recreation use statutes are substantial means of limiting liability. The Michigan recreation user statute creates a new user category that adds to the categories of licence, invitee, and trespasser. Since the statute indicates that it may be invoked only if there has been no valuable consideration paid for the recreation activity, the category of invitee may still be considered. The Michigan Recreational Trespass Act (Mich. Stat. Ann. at 13.1485) defines the recreational trespasser yet the recreational use statute may be invoked whether or not the plaintiff has permission to enter a premises. The trespasser category may still be considered in the assessment of gross negligence or willful and wanton misconduct. As courts interpret these status, however, diverse elements are introduced which create new issues in the civil law arena.

Civil Law Issues

Public Entities

The concept of the recreation use statute has spread in many jurisdictions to include public entities.

Currently 119 jurisdictions have found that recreation use statutes extend to public entities (Kozlowski, 1987). In Michigan this extension has added another defense to negligence actions against the state. Traditionally, the State Department of Natural Resources has sought dismissal of claims by:

1. statute of limitations
2. general governmental immunity
3. public employee immunity (replaced by Tort Reform Act, 1885)
4 lack of possession or control (leasing lands or operations to concession) (Hughes, 1987)

Since the enactment of a recreation use statute (Mich. Stat. Ann. at 13.1485) it has been held that state-owned land is included under this legislation (McNeal v. Department of Natural Resources, 140 Mich App 625).

Municipalities in Michigan are currently covered by the recreation use statute. Williams v. City of Cadillac (1985) held that municipalities were only liable for willful and wanton misconduct which reversed the holding of Anderson v. Brown Bros., Inc., (1975).

It is clear that at present, Michigan courts have given liberal interpretation of the state's recreation use statutes in extending coverage to a wide range of individuals and vertical arrays of government.

In several states the protection offered by recreation use statutes has extended to include federal lands as well. In Michigan, this concept was tested in Miller v. United States Department of Interior (1986). The issues surrounding this case exhibit the major elements in determining the scope of the recreational use statute.

The plaintiff, Jerry Miller, was injured on land within the Sleeping Bear National Lakeshore when he fell or jumped from a rope swing on the banks of the Platte River. There are no fees charged by the National Park Service to enter the park. Miller and a friend were canoeing on the Platte River on August 5, 1980, when they stopped at an area often used for picnicking and sunbathing. Across from this area was a rope swing that had existed for several years. It was frequently used by the public to swing out and drop into the river. Miller had used this swing on several occasions, and on this day made 15 to 20 jumps before the injury occurred. On this last swing, Miller became unbalanced and entered the water head first in a shallow area resulting in a fractured neck and partial paralysis.

Miller argued that the state recreation use statute did not apply in this case because it applies only to licensees and not to invites such as park visitors. Miller also contended that the statute was intended to

open up land for recreational use that would otherwise be unavailable (unlike a National Park).

The National Park Service contended that under the Federal Tort Claims Act, the United States is to be treated as a individual citizen in such cases. The court acknowledged this claim, and therefore, the recreation use statute did apply. Under the statute the defendant must demonstrate willful and wanton misconduct (or gross negligence) as determined by the preponderance of evidence. In Michigan the courts have determined that willful and wanton misconduct is present when there is an attempt to harm or indifference resulting in willingness for harm to occur. The court in this case found no such intent or willingness on the part of the National Park Service and thus gross negligence was not found.

In Michigan we see the general extension of recreation use statute to encompass public entities. In other jurisdictions, such as California and Florida, however, recreational use statutes are currently limited to private landholders (Nelson v. City of Gridly & McPhee v. Data County) (Kozlowski, 1987).

Rural and Urban Lands

The general rhetoric of recreation use statutes has lead to cases surrounding the applicability of the statutes to rural vs. urban lands. The initial intent of

many such statutes was to promote activities such as hunting, hiking, and sight-seeing on private lands. Many courts have determined that these statutes are applicable only to undeveloped or in unimproved lands. In cases involving this issue, focus is on determining the intent of the specific verbage in the given statute. In many jurisdictions recreation uses are enumerated and focus on outdoor, rural activities. Courts in Wisconsin, New Jersey, and Louisiana have interpreted these enumerated uses in the literal sense and have rejected other nonlisted uses as inapplicable (Kozlowski, 1986).

In Michigan the statute delineates recreation activities as "fishing, hunting, trapping, camping, hiking, sightseeing, motorcycling, snowmobiling or any other outdoor recreational uses" (Mich. Stat. Ann. at 13.1485). The courts initially interpreted this to include both rural and urban lands (Yahrling v. Belle Lake Ass'n., Inc., 1985). The Yarling case was subsequentlyly reversed and consolidated with Wymer v. Holmes (1987). Thus the current interpretation of the recreation user statute does not include urban, suburban, and subdivided lands or social invitees.

Excerpted Legal Concepts as Defined by Black (1986)

Assumption of risk: The doctrine of assumption of risk, also known as volenti non fit injuria, means

legally that a plaintiff may not recover for an injury to which he assents, i.e., that a person may not recover for an injury received when he voluntarily exposes himself to a known and appreciated danger. The requirements for the defense of volenti non fit injuria are that: (1) the plaintiff has knowledge of facts constituting a dangerous condition, (2) he knows the condition is dangerous, (3) he appreciates the nature or extent of the danger, and (4) he voluntarily exposes himself to the danger. An exception may be applicable even though the above factors have entered into a plaintiff's conduct if his actions come within the rescue or humanitarian doctrine.

Burden of proof: (Lat. onus probandi.) In the law of evidence, the necessity or duty of affirmatively proving a fact or facts in dispute on an issue raised between the parties in a cause. The obligation of a party to establish by evidence a requisite degree of belief concerning a fact in the mid of the trier of fact or the court.

Cause, n. (Lat. causa.) Each separate antecedent of an event. Something that precedes and brings about an effect or a result. A reason for an action or condition. A ground of a legal action. An agent that brings something about. That which in some manner is accountable for condition that brings about an effect or that produces a cause for the resultant action or state.

Comparative negligence. Under comparative negligence statutes or doctrines, negligence is measured in terms of percentage, and any damages allowed shall be diminished in proportion to amount of negligence attributable to the person for whose injury, damage or death recovery is sought. Many states have replaced contributory negligence statutes or doctrines with comparative negligence. Where negligence by both parties is concurrent and contributes to injury, recovery is not barred under such doctrine, but plaintiff's damages are diminished proportionately provided his fault is less than defendant's, and that, by exercise of ordinary care, he could not have avoided consequences of defendant's negligence after it was or should have been apparent.

Duty. A human action which is exactly conformable to the laws which require us to obey them. Legal or moral obligation. Obligatory conduct or service. Mandatory obligation to perform.

In negligence cases term may be defined as obligation, to which law will gives recognition and effect, to conform to particular standard of conduct toward another. The word "duty" is used throughout the Restatement of Torts to denote the fact that the actor is required to conduct himself in a particular manner at the risk that if he does not do so he becomes subject to liability to another to whom the duty is owed for any

injury sustained by such other, of which that actor's conduct is a legal case.

Due care. Just, proper, and sufficient care, so far as the circumstances demand it; the absence of negligence. That care which an ordinarily prudent person would have exercised under the same or similar circumstances. "Due care" is care proportioned to any given situation, its surroundings, peculiarities, and hazards. It may and often does require extraordinary care. "Due care," "reasonable care," and "ordinary care" are often used as convertible terms.

This term, as usually understood in cases where the gist of the action is the defendant's negligence, implies not only that a party has not been negligent or careless, but that he has been guilty of no violation of law in relation to the subject-matter or transaction which constitutes the cause of action.

Injury. Any wrong or damage done to another, either in his person, rights, reputation, or property. The invasion of any legally protected interest of another.

Gross negligence. The intentional failure to perform a manifest duty in reckless disregard of the consequences as affecting the life or property of another.

Invitee. A person is an "invitee" on land of another if (1) he enters by invitation, express or

implied, (2) his entry is connected with the owner's business or with an activity the owner conducts or permits to be conducted on his land and (3) there is mutuality of benefit or benefit to the owner.

Licensee. Person to whom a license is granted. One who comes on to the premises for his own purpose but with the occupier's consent. For merely, the duty owed to a licensee was that of refraining from wilful, wanton and reckless conduct This rule has been changed and now, in most jurisdictions, the occupier of land owes the licenses the duty of reasonable or due care.

Ordinary negligence. The omission of that care which a man of common prudence usually takes of his own concerns. Failure to exercise care of an ordinarily prudent person in same situation. A want of that care and prudence that the great majority of mankind exercise under the same or similar circumstances. Wherever distinctions between gross, ordinary and slight negligence are observed, "ordinary negligence" is said to be the want of ordinary care.

Negligence. The omission to do something which a reasonable man, guided by those ordinary considerations which ordinarily regulate human affairs, would do, or the doing of something which a reasonable and prudent man would not do.

The failure to use such care as a reasonably prudent and careful person would use under similar circumstances; it is the doing of some act which a person of ordinary prudence would not have done under similar circumstances or failure to do what a person of ordinary prudence would have done under similar circumstances. Conduct which falls below the standard established by law for the protection of others against unreasonable risk of harm; it is a departure from the conduct expectable of a reasonably prudent person under like circumstances.

The term refers only to that legal delinquency which results whenever a man fails to exhibit the care which he ought to exhibit, whether it be slight, ordinary, or great. It is characterized chiefly by inadvertence, thoughtlessness, inattention, and the like, while "wantonness" or "recklessness" is characterized by willfulness. The law of negligence is founded on reasonable conduct or reasonable care under all circumstances of particular case. Doctrine of negligence rests on duty of every person to exercise due care in his conduct toward others from which injury may result.

Proximate cause. That which, in a natural and continuous sequence, unbroken by any efficient intervening cause, produces injury, and without which the result would not have occurred. That which is nearest in the order of responsible causation. That which stands

next in causation to the effect, not necessarily in time or space but in causal relation. The proximate cause of an injury is the primary or moving cause, or that which, in a natural and continuous sequence, unbroken by any efficient intervening cause, produces the injury and without which the accident would not have happened, if the injury be one which might be reasonably anticipated or foreseen as a natural consequence of the wrongful act. An injury or damage is proximately caused by an act, or a failure to act, whenever it appears from the evidence in the case, that the act or omission played a substantial part in bringing about or actually causing the injury or damage; and that the injury or damage was either a direct result or a reasonably probable consequence of the act or omission.

Wilful, wanton or reckless negligence. These terms are customarily treated as meaning essentially the same thing. The usual meaning assigned to "willful," "wanton" or "reckless," according to taste as to the word used, is that the actor has intentionally done an act of an unreasonable character in disregard of a risk known to him or so obvious that he must be taken to have been aware of it, and so great as to make it highly probable that harm would follow. It usually is accompanied by a conscious indifference to the consequences, amounting

almost to willingness that they shall follow; and it has been said that this is indispensable.

Knowledge Base Structure

The knowledge base was written in Production Rule Language, a proprietary symbolic language distributed by Information Builders Inc. The language is a subset of the expert system development package Level 5 which also contains a text editor, compiler, explanation generator, and control mechanism. The control strategy of Level 5 is a backward chaining pattern matching algorithm implemented in Turbo Pascal (a high level programming language). The back chaining control strategy determines the structure of the knowledge base.

The initial structures of TOTO provide the basic declaration of fact types, control statements, and a goal outline:

```
TITLE TORT                      (KNOWLEDGE BASE NAME)

STRING Plaintiff's Name         (STRING is a fact declaration
AND Defendant's Name             indicating that the listed
                                 facts are characters
AND Agency or firm name          representing words)
AND What type of activity
AND Hazard

NUMERIC Today's date            (NUMERIC is a fact declaration
AND Months since alleged         indicating the facts are
  injury                         numbers)
AND How many other
  injuries have occurred
  at the site
```

```
AND AGE
AND M
AND B
AND WW

CONFIDENCE Common knowledge          (CONFIDENCE enables
AND Expert knowledge                  certainty factors
AND The Defendant warned of           to be assigned to
  hazard in question                  facts)
AND The Defendant instructed
  P of hazards
AND P
AND G
AND M
AND U
AND A
AND C
AND S
AND aS
AND sV
AND B
AND P Conduct
AND P knowledge
AND P ability to avoid
AND P's omission
AND D had knowledge
AND D has ability to avoid
AND D's omission
THRESHOLD = 1        (THRESHOLD sets the minimum value
                      where a confidence factor
                      associated with as fact will be
                      considered true)

1 Setup              (This is the goal outline which
1.1 Sum               drives the system)
```

The STRING fact declaration initiates a query to the system user to enter text so that the system may use it in the diagnostic session. Quite simply, the text entered for names will be utilized by the system to create customized dialogue during the consultation session.

NUMERIC fact declaration preforms two functions in TOTO. (Months since alleged injury), (How many other injuries have occurred at the site), and (Age) act similar to STRING facts in that they are specified by the user. (M), (B), and (WW) are facts that will be assigned values based on user responses. These are the major "fuzzy" operators that will be discussed later.

CONFIDENCE is a control statement that provides a means as to assess the user's confidence in a state of fact. This value is also introduced to facts by the programmer and by mathematics preformed by the system in response to the system state. In TOTO, CONFIDENCE is often utilized to map fuzzy numeric clauses to symbols. This effort basically is an attempt to translate ordinal (symbolic) data into an interval scale to facilitate TOTO's understanding of open texture predicates in relevance to case facts.

THRESHOLD is another control statement that sets the minimum value at which the system will consider a fact true. THRESHOLD works exclusively with facts that have CONFIDENCE associated with them. The default setting of THRESHOLD IS 50 WHERE confidence < 50 indicates false and CONFIDENCE > indicates true. In TOTO, However, the THRESHOLD is set at 1 because in the majority of cases CONFIDENCE has been modified by the programmer to preform fuzzy logic.

The goal outline is the basic driving force behind the system. The system's ultimate direction is determined by the attempt to meet the goals in the outline. TOTO queries the user and preforms calculations until the goals are met or all alternatives are exhausted. There are hundreds of paths TOTO can take to satisfy these goals based upon the facts surrounding case as reported by the user.

The control strategy is deemed backward chaining because the system begins with the goal and searches the set of interdependent rules to meet it. In TOTO the goal (Setup) provides the impetus to gather factual data relevant to the case prior to entering into legal decision making. The secondary goal (Sum) provides the impetus to proceed with legal analysis and the collection of facts and attributes surrounding the case in hand. TOTO's goal is to assess landholder negligence as a defendant as well as the potential contribution to the injury by the plaintiff. The (Sum) goal is satisfied in the following rule.

```
RULE to sum
IF Page one response
AND Page two response
OR NOT Page two response
THEN Sum
```

(Page one response) is a condition to (RULE to sum) as well as a conclusion to several other rules. (Page one response) as a conclusion to other rules is the

terminus to the evaluation of the defendant's negligence. (Page two response) is also a terminal conclusion that is satisfied by assessing the comparative negligence of the plaintiff. Since not all cases involve comparative negligence the OR clause is implemented.

Rule Structure

The structure of individual rules is based on boolean logic which is naturally intuitive. Each rule must have a title which assists in debugging and the production of explanation facilities. The IF statement is always the initial condition of the rule followed by more conditions linked to an AND command or OR command. The logic of the rule is strictly sequential. The THEN statement is followed by the state of fact associated with satisfying or "firing" the rule. The ELSE statement may be placed after the THEN command to provide information on the failure of the rule to fire for other rules to act upon.

Most of the rules in TOTO are to some degree dependent upon conclusions of other rules. Some have a shallow structure where all conditions are virgin, whereas others may be influenced by other dependent rules. Rules that have the deepest structure become recognizable as concepts and are in TOTO labeled METARULES. The set of METARULES embody the basic legal

rules and inferencing strategies that constitute the problem-solving behavior in the macro sense. In the micro sense we see the difficult problems as well as routine rules of fact as the foundation of the METARULES. CONTROL RULES are a class above METARULES that reside closest to the goal outline and direct basic problem solving as well as reporting facilities. The resulting structure is simplified and illustrated in Figure 9.

Returning the (Sum) CONTROL RULE and its conditions of:

```
IF Page one response
AND Page two response
OR NOT  Page two response
```

we see that these conditions are also conclusions to other control rules. For example, the (Page one response) condition is a conclusion to several other rules including (output no duty):

```
RULE output no duty
IF No Liability ordneg
OR No Liability grosneg
AND NOT Duty
THEN Page One response
AND DISPLAY No burden duty
```

This rule simple states that if TOTO cannot find negligence of any kind because there is a failure to demonstrate legal duty, then make a report discussing these results in relation to the case in hand.

The function of (Page two response) is similar yet is only activated when negligence by the defendant is

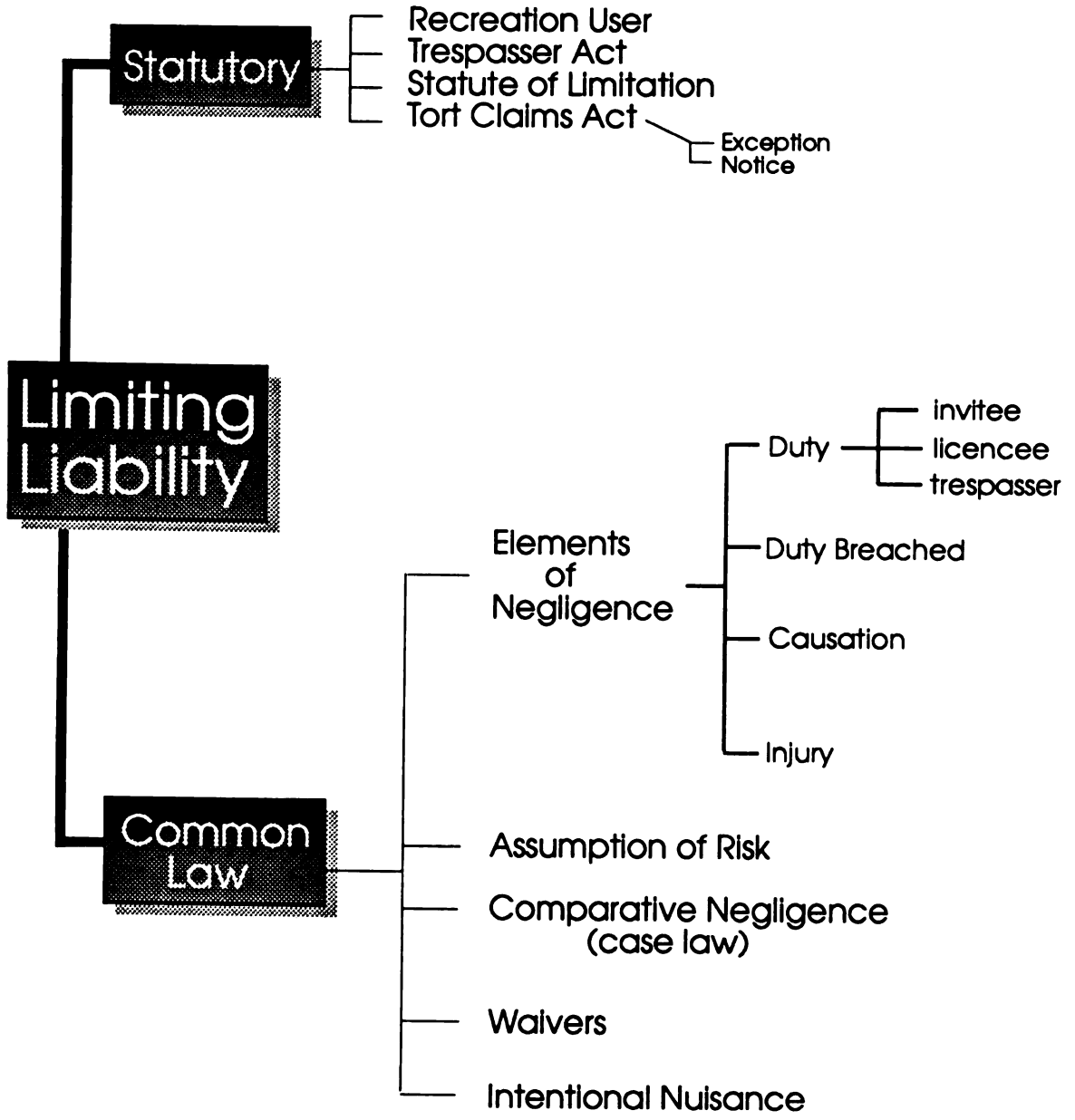


Figure 9. Modules in TOTO's Knowledge Base.

discovered. The rules that conclude with (Page two response) are the series of METARULES that assign the appropriate legal defenses for the defendant. For example:

```
META RULE to invoke rec use statute
     IF Liability ordneg
     AND invoke rec use statute
     THEN No liability

     AND Page two response
     AND DISPLAY rec use

META RULE to invoke comparative negligence
     IF Liability grosneg
     AND CN exists
     THEN Partial Liability
     AND CONF (LL):=100-CONF(CN)
     AND Page two response
     AND DISPLAY compneg
```

IN the first rule, the condition (AND invoke rec use statute) sends the back chaining algorithm to search for this as a conclusion of other rules. In this case TOTO would discover the DEFENSES module and subsequently the set of rules that assess the potential application of the recreation use statute. If all conditions are met, the (META RULE to invoke rec use statute) will fire and a custom explanation of the case assessment will be generated.

In the (META RULE to invoke comparative negligence), the search process is similar, except that here numeric

values are discovered and comparative negligence is calculated.

The DISPLAY operator acts to call a canned display screen that has open areas in it that allow for customizing the response. The names of litigants and factual data gathered during the session are dropped into the DISPLAY screen to make explanation of TOTO's conclusions customized to the current consultation. The TEXT command has a similar function, but is utilized to customize specific queries during the session. For example:

TEXT Permission
Did [Plaintiff's name] have permission from the [Defendant's Name] to enter the premises owned and controlled by [Agency or firm name]?

Lack of permission includes areas that have been marked "Closed at Dusk" or "No Swimming."

The use of TOTO would view a screen similar to the following:

Did Robbin Smith have expressed or implied permission from Fred Nugent to enter the premises owned and controlled by the Michigan Department of Natural Resources?

Lack of permission includes areas that have been marked "Closed at Dusk" or "No Swimming."

Under the (Setup) goal in the goal outline, TOTO has elicited the factual information needed for this particular DISPLAY.

The EXPAND operator is again similar to DISPLAY and TEXT in that it provides information to the user. When the EXPAND icon is clicked by the system user supplemental explanatory information is presented. The information is context sensitive and will provide explanations relative to the current rule under consideration.

Search Strategy

The hierarchical set of rules in the knowledge base are searched by the back chaining inference mechanism to find a combination of conditions that will ultimately meet the goal statements in the goal outline. This search strategy means TOTO will always attempt to find the shortest path to a goal statement. As answers are provided by the user, a new set of shortest paths are brought into consideration. The full breadth of TOTO's knowledge base is considered only when it encounters the most difficult or unusual case circumstances. In such cases the knowledge of TOTO has been exhausted and the system will fail to reach a conclusion. The user than has the ability to change his/her responses to TOTO's

queries in the attempt to discover why the system was confounded.

The breadth of knowledge may be represented as the "world according to TOTO." Sequential responses by the system user continually modify the search space under consideration. Thus in most cases most of TOTO's knowledge base is never brought into consideration. For example, if TOTO discovers that the plaintiff is a legal trespasser upon the defendant's premises, the entire branch of knowledge surrounding the issue of ordinary care is cut off. This determinism comes into play when straightforward rules of law are under consideration. When the legal principles under consideration are subtle or of open texture, small branches of the knowledge base are pruned in a process of gradual refinement. Thus easy problems in TOTO have the greatest ability to cut entire knowledge branches, whereas difficult problems have less pruning power. Difficult problems require a more meticulous approach to pruning the search space.

Model Structure

The basic knowledge modeled in TOTO is separated into two units. The first unit is the knowledge needed to assess the burden of proof which lies upon the shoulders of the plaintiff. In its simplest form, this involves proving that the following elements are present:

A DUTY to meet a standard of care for the plaintiff
A BREACH of that duty
A CAUSAL connection
An INJURY

The second unit in TOTO assesses the potential defenses available to the defendant. The burden of proof unit must have determined that negligence exists in order for the second unit to assesses defenses. In order to demonstrate the actual content of the knowledge base the following annotated outline is provided.

Elements of Negligence

DUTY

Establish relationship between players
Defendant type:
Public or
Private
individual
individual & agency/firm
Administrator
participates in tortuous conduct
hiring
training
discretionary function
ministerial function
Employee
act within scope of duty
while on duty
Volunteer
within scope of duty
viewed as an employee

Plaintiff type

Invitee
permission-yes
on D,s proprietorship
express invitation by D
paid fee to enter to D
or fee for activity

Licensee
permission-yes
no business transaction with D
no cash exchange with D
Trespasser
no permission
physical invasion of D,s premises
and "park closed" signage
or "no swimming after dark"

Minor

Under 13 years of age

BREACH

STANDARD

Ordinary negligence
only invitee can claim lack of ord care
based upon "reasonable prudent man"
OR reasonable prudent professional
inspect, repair, remove rule
warning or instruction
STANDARDS
written and customs, must be
certain
uniform
well known
obvious
Hand test

Magnitude of Risk v Burden of
Alternative conduct

Magnitude of Risk =
foreseeable probability
of harm + gravity of harm

Feasibility of Alternative
Conduct =
relative cost of
alternative conduct +

relative utility of
safer conduct +

relative safety of
alternative conduct +

Willful and Wanton Misconduct

players defined by statute
TRADITIONAL DEFINITION
D's knowledge of situation requiring ordinary care to avert injury
D's omission of care when threat is apparent
D's intent or omission of care
MICHIGAN DEFINITION
intent to harm
or indifference resulting in willingness for harm to occur

Trespassers
- Discovered
  - D discovers P
  - D continues risk activity
  - not natural land condition creating hazard
  - D knows P will not discover hazard
  - D has control of elements creating hazard
  - D provides no warning or instruction
- Frequent
  - frequent intrusion to specific area
  - active operation that create risk of bodily harm
  - no warning of hazard
  - D knows hazard will not be discovered
- Minor
  - D knows or should know minors will trespass
  - D aware of danger
  - hazard not natural land condition
  - D had power to limit risk

CAUSATION

Cause in Fact

"butfor" conduct (direct string of cause-effect events)
coterminous--hazard & injury
physical contact
avoidance of hazard

Proximate Cause--Unforseeable Consequences

consequences were foreseeable
P was in foreseeable zone of danger
or rescuers caused injury

Prox Cause--Intervening Cause

intervening cause foreseeable
consequences of intervening causes foreseeable
Non-extraordinary weather conditions weather
third party negligence
third party criminal conduct

INJURY

person
chattels

Defendant's Defenses

Expressed Assumption of Risk
Signed waiver (useful evidence of assumption of risk)
not against public policy
unambiguous language
voluntary participation
adult cannot sign away rights of minor

Implied Assumption Risk

P knows, appreciates, understands risk
voluntary participation
conduct manifests consent

Statute of limitation

P knows, appreciates, understands risk
voluntary participation
conduct manifests consent

Statute of limitation

3 years after injury
after 3 years must prove latent or delayed causation

Michigan Recreation Use Statute

All lands where no fee is paid is excluded from actions against D where ordinary negligence is the issue
Thus P must seek willful and wanton misconduct by D
State Park fee is for parking thus under protection
IN MI all public agencies are protected (local, state, fed)
Goal is to minimize reduction of recreational opportunity

Comparative Negligence

Conduct by P enhancing CAUSATION of injury
Use willful and wanton misconduct rule against P conduct shows indifference to harm self

P has knowledge that ordinary care would avert injury

P has ability to avoid injury
P conduct show omission of care
If found, D's negligence is reduced up to 50%
D 60%/P 40% as example
Damages (payment) is adjusted to fit proportion

Open Texture Predicates

The determination of reasonable conduct in ordinary negligence cases is based upon what a reasonable and prudent person would do in a given situation. The "reasonable and prudent person" guideline is ultimately assessed by a jury or judge from case facts and arguments based on previous cases. This determination is not an empirical one and thus remains problematical in the

determination of reasonableness. TOTO, however, is limited to pretrial decision making and the behavior of juries is not relevant.

The pretrial determination of breach of duty will include an evaluation of reasonable conduct based on a loose collection of legal guidelines. A classic formulation of determining when conduct is unreasonable is the "Hand" test (United States v. Carrol Towing Co. (2nd Cir 1947), L. Hand, J.).

> a risk is unreasonable when the foreseeable probability and gravity of harm outweigh the burden to D [defendant] of alternative conduct which would have prevented the harm (Kionka, 1988).

This test was selected to be formalized into the knowledge structure because it can be broken into components that fit the structure of production rules. In the simplest form, the test stated as:

Magnitude of risk v Burden of alternative conduct

where

MAGNITUDE OF RISK = probability + gravity of harm

and

BURDEN OF ALTERNATIVE CONDUCT = relevant costs

The relevant costs associated with the burden of alternative conduct include:

1. the importance or social value of the activity or goal of which D's conduct is part;
2. the utility of the conduct as a means to that end;

3. the feasibility of alternative, safer conduct;
4. the relative cost of safer conduct
5. the relative utility of safer conduct
6. the relative safety of alternative conduct (Koinka, 1988)

Thus, the burden of alternative conduct is the sum of the six factors. In order to operationalize these variables and make them usable in the knowledge base, they were transformed into rule sets that incorporated confidence ranking. The degree of membership for both MAGNITUDE OF RISK and BURDEN OF ALTERNATIVE CONDUCT is determined by values associated with the individual factors. During a consultation session, the user is queried as to how case conditions relate to these factors and to rank compliance to the factor concept. A METARULE guides the process and calculates BURDEN OF ALTERNATIVE CONDUCT and BURDEN OF ALTERNATIVE CONDUCT membership values. By balancing the opposing values, "reasonable conduct" is accepted or rejected.

The same method was utilized to determine willful and wanton misconduct. If the plaintiff is an invitee or licensee, a general case assessment is invoked. The determination of willful and wanton misconduct is based on Michigan case law as follows:

1. knowledge of a situation requiring the exercise of ordinary care and diligence to avert injury to another
2. ability to avoid the resulting harm by ordinary career and diligence in the use of means at hand and

3. the omission to use such care and diligence to avert the threatened danger when to the ordinary mind it must be apparent that the result is likely to prove disastrous to another (Thomas v. Consumers Power Co.).

and

> Willful and wanton misconduct is distinguished from ordinary negligence by intent to harm or by an indifference of the defendant of a defendant in the presence of the probability of harm which is tantamount to a willingness for that harm to occur (Williams v. City of Cadillac).

The concepts for representing willful and wanton misconduct were formalized into rules and METARULES incorporating confidence ranks. When the confidence numbers are gathered for each fact they are summed and averaged to create an aggregate value. As the aggregate value increases the potential for willful and wanton conduct increases. If the value surpasses a threshold then willful and wanton misconduct is confirmed. If the aggregate value does not reach the threshold, it is rejected.

The assessment of willful and wanton misconduct where the plaintiff is a trespasser follows a similar procedure, but incorporates a more extensive evaluation of case facts. Special rules sets assess condition where trespass is frequent, discovered by the defendant, or involves a minor. These special cases require an evaluation of the defendant's knowledge of trespass conditions in order to assess his/her conduct.

Analysis and Results

TOTO has reached the stage of a research prototype system. Figure 10 illustrates the range of development stages for expert systems.

There are more than 120 rules and 300 fact statements in TOTO. The rule set was condensed from more than 300 by the creation of METARULES and attribute/value (a/v) pairings. As discussed previously, METARULES were implemented to provide a hierarchy of rule classes to simplify the knowledge engineering process. The process of organizing knowledge into rule classes created the opportunity to isolate rules that have several special functions. Thus, some rules are primarily collections of facts, whereas others handle fuzzy math or provide control to the program. This division of labor reduced the need for redundant actions completed by several rules.

The rule set was further condensed by extensive use of attribute value pairings. The following rule set is an implementation without a/v pairings.

RULE to determine public control

IF Public

AND Defendant is in the public trust

Development Stage	Description
Demonstration Prototype	The system solves a portion of the problem undertaken, suggesting that the approach is viable and system development is achievable. One to three months to develop.
Research Prototype	The system demonstrates credible performance on the entire problem but may be fragile due to incomplete testing and revision. One to two years development time.
Field Prototype	The system displays good performance with adequate reliability and has been revised based on extensive testing in the user environment. Two to three years development time.
Production Model	The system exhibits high quality, is reliably fast with efficient performance in the user environment. Two to four years development time.
Commercial System	The system is a production model being used on a regular commercial basis. Four to six years development time.

Figure 10. Evolution of Expert Systems (From Waterman, 1985).

AND Defendant is on the board of directors

THEN Classified defendant

RULE to determine public control

IF Public

AND Defendant is in the public trust

AND Defendant is the enterprise administrator

THEN Classified defendant

RULE to determine public control

IF Public

AND Defendant is in the public trust

AND Defendant is an employee

THEN Classified defendant

RULE to determine pubic control

IF Public

AND Defendant is in the public trust

AND Defendant is a volunteer

THEN Classified defendant

Now with a/v pairings on rule handles the task.

RULE to determine public control

IF Public

AND Defendant IS in the public trust

AND Defendant IS the enterprise administrator

OR Defendant IS on the board of directors

OR Defendant IS an employee

OR Defendant IS a volunteer

THEN Classified defendant

The IS statement enable the attribute "Defendant" to take on a range of values. The status of "Defendant" will be determined by the system user or deduced by TOTO.

Test Cases

During development, TOTO was continually tested by running hypothetical case facts through the system and monitoring its behavior. When problems were encountered, the knowledge base was modified to correct the aberrant behavior. As the knowledge base grew to more than 100 rules, the corrections and additions tended to introduce more errors than they fixed. This problem was addressed by standardizing test cases which would isolate the effects of modifying the knowledge base.

At the stage of research prototype TOTO's ability to identify the important elements in a case was tested by using hypothetical case facts during consultations by domain experts. Initially, the use of actual cases in the Michigan civil law arena were proposed as testing devices. This approach was problematical for the design of much of the knowledge base was based on these cases. There would be little use testing the system on what it

already should know. Thus hypothetical cases were constructed by the domain experts to supply facts for TOTO to process. The following test cases and discussions of TOTO's reasoning illustrate the level of performance the system has attained.

Test case 1. In this test case the plaintiff, Robbin Smith, entered the defendant's premises to engage in a game of golf. Phil Dirt's golf course charges a $15 green fee and requires golfers to sign a release accepting the risk of being struck by golf balls. Phil Dirt does not own the land upon which the course lies, but leases the premises to run his business operation. While driving her golf cart over a bridge that spanned a stream, the back wheel slid over the edge and sent the cart into the opposite bank of the stream striking a cement foundation that supported a since removed bridge. Smith suffered severe head injuries as a result of the incident. Other golfers have lost control in a similar manner, yet remained "hung up" on the bridge. The defendant had, on two separate occasions, used his tractor to tow carts of the structure having one wheel slide off the edge of the bridge. In order to proceed with a civil case against the defendant, Smith has the burden of proof to demonstrate that negligence exists and consults TOTO to assist to do so.

The user began the session by entering the day's date, the defendant' name, the plaintiff's name, and the name of the firm or agency that the defendant is associated with (see Appendix A for complete user session report). Then TOTO elicits the activity type in question for evaluation later. At this point, TOTO is only aware of the rudimentary facts associated with the case. These facts, however, will enable TOTO to address the litigants by name and by facts associated with the case. TOTO uses information learned in the session to customize queries so that only relevant questions are posed to the user. This process eliminates the asking of redundant or irrelevant questions during a consultation.

The plaintiff, as identified as Robbin Smith, is then assessed as to her legal status while on the premises of the defendant, Phil Dirt. The rule for PERMISSION is invoked and TOTO determines whether or not Robbin Smith is a TRESPASSER or of some other status. TOTO determines that she is not a trespasser, and thus, should be assessed as a licensee or invitee.

The sequence of TOTO's logic is not monotonic, and thus, it pursues the solving of the case by the shortest path available. This search strategy is called "depth first" because TOTO will always search the entire knowledge base for the simplest solution. The upper half of Figure 11 illustrates the knowledge base as an

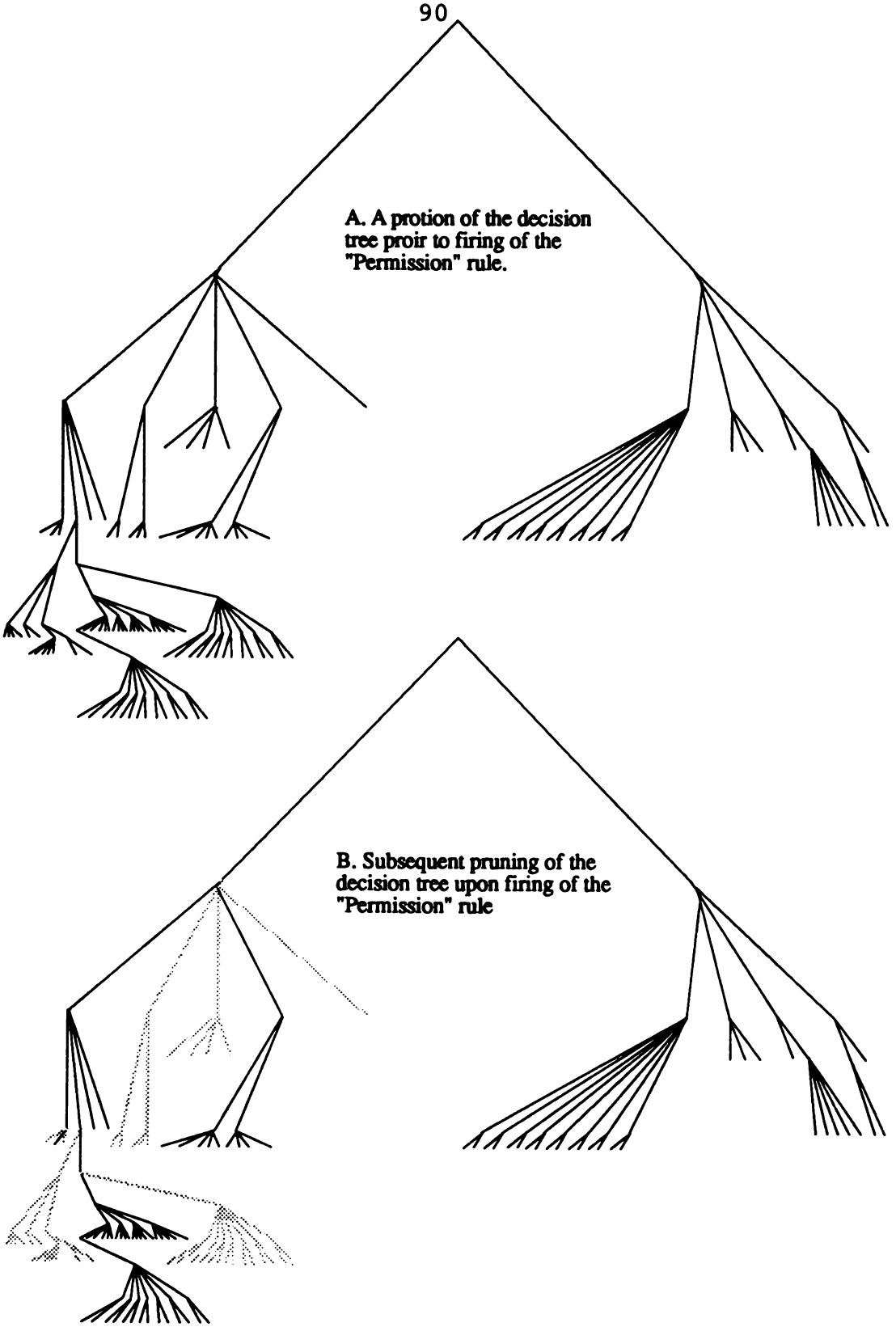


Figure 11. Firing of the Permission Rule and Subsequent Pruning.

inverted decision tree. As TOTO gains information during a session, the branches are pruned, narrowing the available solutions. In the case at hand, the firing of the PERMISSION rule invokes a search strategy that disregards rules of law associated with trespassers and the tree is pruned as in the lower half of Figure 11.

Now TOTO attempts to evaluate the defendant by searching the METARULE "to determine landholder type." The user supplies the fact that the premises in question is owned by a private interest. Next TOTO presents a list of options to the user to determine whether or not the defendant owns or leases the premises, and was in actual control of the premises (including land conditions) at the time of the alleged injury.

The next series of queries attempt to determine the nature of the defendant's operation. In this case, TOTO determines that Phil Dirt runs a proprietary business operation to provide golfing opportunities to the public. Also, it becomes clear that the public is openly invited to play at the course and that Phil charges a fee for the activity. It is disclosed that the plaintiff, Robbin Smith, entered the premises to play golf, and willingly paid a feed to do so. Thus TOTO has completed assessing both the plaintiff and defendant and classified Phil Dirt

as the proprietor and manager of land condition for the course. Robbin Smith has been identified as a business invitee.

This information is gathered or deduced for the purpose of determining the relationship between the litigants at the time of the alleged injury. The determination of the nature of this relationship enables TOTO to the DUTY requirement in negligence law. At this point, TOTO has established that the defendant, Phil Dirt, has a duty of some sort to protect Robbin Smith from harm. The exact level of care required by the defendant will be assessed when TOTO proceeds.

A recurring problem in legal expert systems is the requirement of the user to exercise a degree of legal judgment during system consultation. In TOTO this problem is first encountered when the user must decide if the case is one of willful and wanton misconduct or one involving ordinary negligence. The user is prompted to decide based upon previous experience or the information provided on screen. In some cases the user may select the inappropriate type of negligence to consider. For example, if the plaintiff has been classified as a trespasser, they are unable to propose a suit based on ordinary negligence. If this situation arises, TOTO refuses the line of reasoning, explains why, and returns to allow the user to try again.

In the case at hand, the plaintiff will pursue ordinary negligence against the defendant. In order to assess the standard of care, the defendant should provide to ensure safety for the plaintiff TOTO examines his/her level of expertise in the recreation activity and the existence of relevant industry standards. Phil Dirt was assessed to have a high level of expertise in golf and golf course management. Also, there are design and maintenance standards for the golf course industry. TOTO queries the user as to the certainty of the standards, their uniformity, and that they are well known and obvious. Here the standards do not have to be written to meet these criteria. TOTO then concluded that relevant safety standards exist and that with the expert knowledge of the defendant, there is a measurable standard of care due to the plaintiff. The user is queried to estimate the defendant's compliance to the standard on a scale of 1 to 100. This estimation will be combined with other estimators to determine the reasonableness of Phil Dirt's conduct.

The next series of queries revolve around the attempt to assert that a breach of duty exists. The user is asked to rank his/her confidence in the defendant performance basic measures to ensure safety for the recreating public. In this case, the user responded as follows:

Defendant inspects the premises regularly	SCORE
to discover potential hazards to the public	67
Defendant removes discovered hazards	45
Defendant provided warning of hazards	False
Defendant provided instruction on how to avoid hazards	False

To conclude the assessment of a potential breach of duty the issue of foreseeability is brought into the session. Here TOTO queries the user as to the frequency of injuries under similar circumstances and the defendant's ability to anticipate future similar injuries. Again, the user places confidence values in association with his answers. These confidence values are combined with the others obtained in the "breach" module and used by TOTO to calculate membership in the "breach" or "no breach" sets. Fuzzy numbers and set theory is utilized to transform discrete interval data into group memberships. Figure 12 illustrates the difference between traditional logic and the fuzzy logic TOTO utilizes to determine the reasonableness of the defendant's conduct. The top graph maps the degree to which reasonableness belongs to the value "low." As the degree of membership increases, the reasonableness decreased on a continuum. The bottom graph illustrates the traditional representation of low reasonableness as a

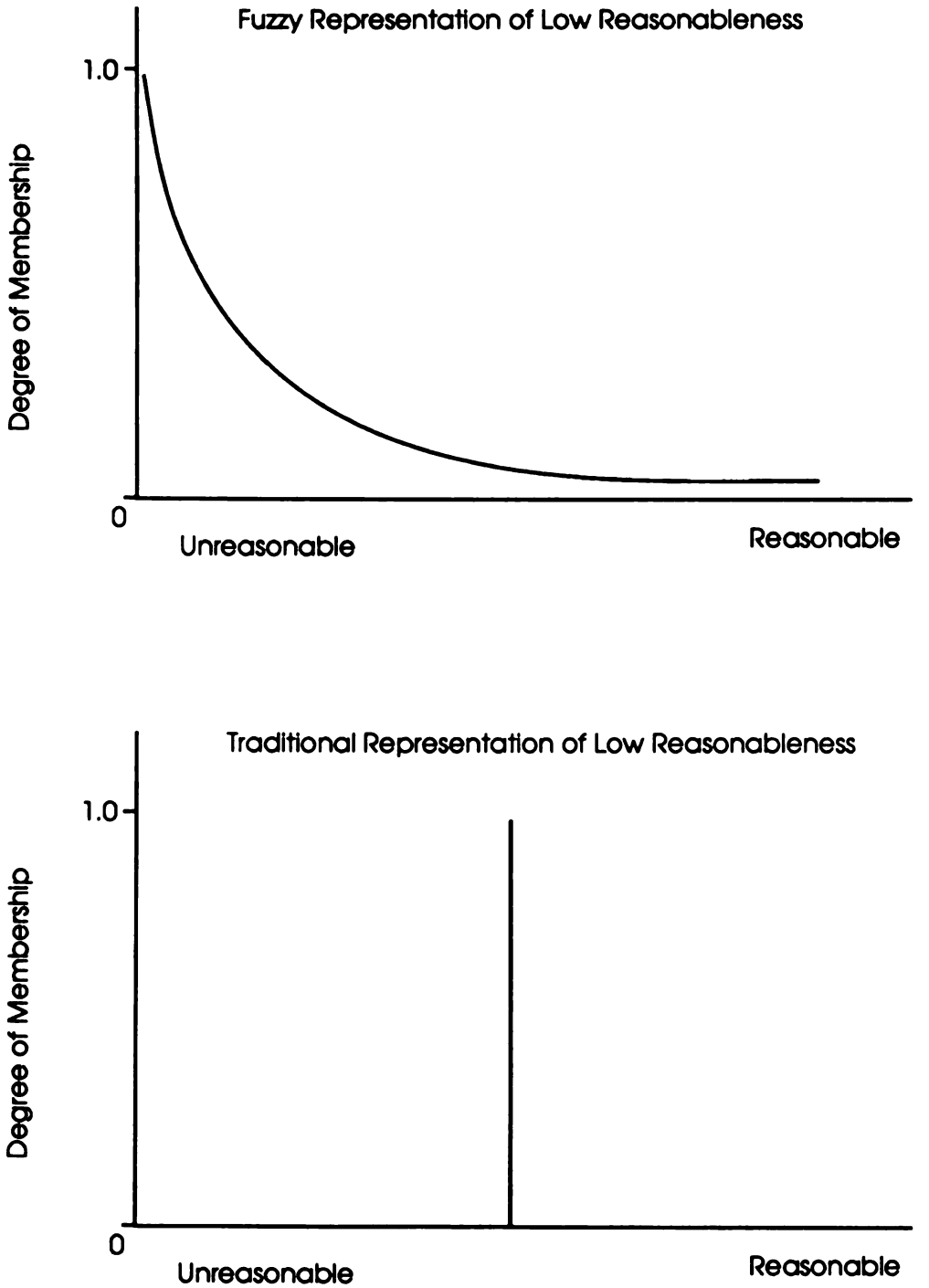


Figure 12. Traditional Logic v. Fuzzy Logic.

dichotomous true/false state of fact. TOTO uses both methods to determine the state of "reasonableness" and the determination of a breach of duty. In this case, it was determined that there was a breach of duty and the issue of the injury was brought into session.

The module that assesses the injury to the plaintiff is straightforward in that the user is posed only yes/no questions. The plaintiff, Robbin Smith, suffered physical harm was substantiated by a physician and thus the injury was considered valid.

The issue of the causal link between the breach of duty and the injury focuses on both space and time dimensions. Initially, however, TOTO assists the user in determining the type of causation to be considered. Within the array of cause types, it was determined that a "cause in fact" would be assessed. It was determined that the injury would not have occurred "but for" the existence of the hazard. It was also determined that the hazard in question was in existence at the moment of the injury and that the injury resulted from direct contact with the hazard. TOTO subsequently concluded that there was indeed cause in fact in this case.

At this point the line of reasoning report reveals that TOTO has collected enough information to conclude that ordinary negligence exists in this case. Thus, the plaintiff's burden of proof to demonstrate duty, breach

of duty, cause, and injury was successful. Now the system acts in behalf of the defendant to discover potential defenses to the negligence.

The first TOTO pursues is to invoke the statute of limitations. Since the injury occurred 13 months prior to the consultation this attempt fails. The user then responds that a waiver was signed prior to using the golf course. The language of the waiver, however, is discovered not to mention the type of risk that led to the injury. Thus, the assumption of risk defense is defeated as well.

TOTO concluded analysis of the case by asserting that negligence exists with no serious threat of defenses proposed by the defendant.

Test Case 2. The plaintiff Fred Nugent was camping on a Michigan State Forest near an abandoned gravel pit that contained a pond that was used for swimming. Campers, as well as the local public, used the pond as a swimming hole, even though the entry road was posted with a "no swimming" sign. Nugent was swimming and drinking beer with friends and driving from a platform that was constructed on an overhanging tree. Nugent made several dives from the platform and commented to the others that they should be careful to avoid some cement fragments that were farther out than the normal point where one

enters the water when diving. After a few more beers Nugent, an accomplished swimmer and diver, was challenged to attempt to dive over the cement blocks into the water beyond. The first dive was successful, yet Nugent scraped his knee on the cement. The second dive was not successful, and Nugent struck his head on the cement and was paralyzed.

The DNR posted the "no swimming" sign, and at one point, removed the diving platform because a swimmer broke her ankle upon jumping from the platform. Since the defendant paid a fee for camping or swimming, the DNR assumed that protection from the state's recreation use statute would relieve them from civil actions.

These facts and others supplied by the user were input into TOTO to assess the potential for negligence and potential defenses. The complete line of reasoning report is presented in Appendix B.

The first module in TOTO gathered basic information to customize subsequent queries and results screens. The defendant is identified as a manager of the lands for the public trust that does not charge a fee for dispersed camping. Thus, in this case, the defendant does not operate a business operation which would influence the degree of due care owed to the plaintiff. The land was unrestricted state property and by default, the plaintiff had permission to enter and use the premises. TOTO

determined that Fred Nugent was licensee on the premises which precludes the using for ordinary negligence. If ordinary negligence was pursued at this point TOTO would allow the attempt, yet would advise that this path of reasoning is futile. Guidance would be provided until the user pursued willful and wanton misconduct on the part of the defendant.

The next series of queries focuses on addressing the potential for willful and wanton misconduct by the defendant. As with test case 1, this assessment utilizes fuzzy sets to assign membership or lack thereof. The user's responses are summarized below.

	SCORE
Did D have knowledge of the hazard in question:	100
Did D have the ability to avoid P's contact with the hazard?	70
Did D's omission to remove the hazard result in the injury?	60
Did D show intent to harm P	0
Did D's conduct show indifference to weather the hazard would harm P?	90

These responses in combination with the level of care owed to the plaintiff led TOTO to assign the defendant to the willful and wanton conduct set. As with tests case 1, it was next determined that there was injury in fact. The next step was to assess the causation for the injury. With prompting by TOTO the

user selected the cause in fact path for analysis. In this case linking the hazard to the injury was not difficult. The water depth was sufficient for diving and the injury would not have occurred but for the existence of the submerged cement blocks. From the line of reasoning report, it can be seen that at this point, TOTO has enough information to assert negligent conduct on the part of the defendant. Immediately the search for potential defenses is conducted.

Since it has only been 15 months since the injury, the statute of limitations defense was eliminated. The next defense considered was that of comparative negligence. Here the plaintiff is assessed in the same manner as the willful and wanton misconduct of the defendant. The responses to TOTO's queries are summarized below.

	SCORE
Did P have knowledge that ordinary care would have averted the injury?	69
Did P's conduct show indifference to whether harm would result?	75
Did D have the ability to avoid the injury with ordinary care?	83
Was there an omission of such care when the threat was apparent?	90

From these responses, TOTO concluded that comparative existed and weighed that against the negligence of the defendant. In the final report screen, TOTO summarized its findings and allocated 79% of the negligence to the plaintiff. Comparative negligence in Michigan, however, relegates fault to the plaintiff to where it is "not greater than" the defendants. Thus, the defendant will be responsible for 50% of damages.

Test case 3. The third test case was designed to enter the branch of the knowledge base that handles the situation where the plaintiff is a trespasser. The full history of the case is displayed in Appendix C.

As with the other cases, the beginning screens gather factual information to enable TOTO to generate custom text for the session. In this case the plaintiff trespassed upon the defendant's gravel pit operation to fish in a pond therein. The user asked TOTO to pursue ordinary negligence, yet TOTO refused, and recommended that alleging willful and wanton misconduct is the only avenue open to trespassers. This route was selected. It was subsequently determined that the plaintiff was a frequent trespasser that the defendant was aware of. In order to determine the defendant's duty to the plaintiff, TOTO queried the user as to the nature of the injury. These queries disclosed that there were active operations

that could injure the plaintiff, that these conditions are man made (rather than natural) and that they would not readily be discovered by the plaintiff. This led TOTO to assert that there was willful and wanton misconduct by the defendant.

Next it was determined that there was injury in fact and that there was a causal link between the hazard and the injury. The causation type selected included an intervening element. This element was considered foreseeable so the causal link was substantiated. At this point, TOTO had gathered enough information from the interview to assert that there was willful and wanton misconduct by the defendant.

Now relevant defenses were considered. Since TOTO knows the status of the litigants and the case conditions, there is not consideration of defenses that will not apply. For example, this case is one of alleging willful and wanton misconduct by the defendant, and the language of the Michigan recreation use statute excludes protection from this type of negligence. Thus TOTO ignores the defense. Ultimately, the comparative negligence defense was invoked which reduced the claim on the defendant by 50%.

This test case uncovered an error in TOTO's knowledge base. There was a failure to correctly assess the facts surrounding the trespass. The user was forced

to select from a range of conditions surrounding the trespass including as follows:

Select the appropriate conditions of the trespass:

A. Trespass was frequent by the plaintiff

B. Trespass was discovered by the defendant

C. Trespass was by a minor

D. None of the above

TOTO forced the user to select the statement that most closely resembled the case conditions even though more than one may apply. In this test case, the trespass was frequent and by a minor yet the user selected option (A). This posed no problem in assessing the negligence, but did so for the defenses. Remember that TOTO asserted that there was comparative negligence on the part of the plaintiff. This essentially means that the plaintiff demonstrated willful and wanton disregard for his own safety. By selecting option (A) TOTO never considered the age of the plaintiff which is this case was six years. If TOTO's protocol was correct the comparative negligence defense would not be entertained for legally, a minor is incapable of willful and wanton disregard for his safety. This problem in the rule base can be corrected, but it highlights one of the difficulty of testing program at this stage of development.

Discussion

The three test cases presented here are a small portion of the full array used to validate the program. They represent both adequate and poor performance in identifying key issues of a case. The tests are qualitative assessments of the program's performance and are judged by subjective measures. Testing of the knowledge base is problematical because there are an extensive number of combinations of rules that TOTO may utilize in analyzing a case. The number of potential combinations can be automatically calculated by creating a knowledge tree (a function in the Level 5 expert system shell). A knowledge tree was created, yet it could not be viewed or printed in its entirety. The document was too large to fit in the computer's memory. Less than one-forth of the knowledge tree constituted more than 500 pages of text. A sample of the knowledge tree output is included in Appendix D.

The combinatorics of the knowledge base makes exhaustive testing very time consuming. To develop the system beyond research prototype, the knowledge base could be tested module by module. The METARULES then could be tested on how they manipulate the modules.

Hays-Roth, Klahr, and Mostow (1986) have outlined sources of error that may be uncovered during the testing

process as listed in Table 1. The problems with TOTO's performance fall into some of the categories listed.

The first problem of excess generality is manifest in TOTO's ability to determine who is the defendant in a case. For example, the rules specify that a public sector defendant is either an individual, the agency at large, or both. Here the case of multiple defendants is ignored.

The fourth and sixth problems were demonstrated when a domain expert and the programmer's expectations were not met during a test case. TOTO quite simply misapplied the Michigan recreation use defense for two reasons: the rule was conceptually incorrect and the syntax of the rule was invalid.

The seventh problem listed in Table 1 of inadequate integration is clearly displayed in test case three above. In the search for applicable defense, TOTO selected the path of comparative negligence because the plaintiff was declared a frequent trespasser. In reality the plaintiff was both a minor and a frequent trespasser. Thus TOTO would not reject the comparative negligence defense as it should in this case.

The aforementioned problems are expectable, given the developmental stage of TOTO as a research prototype. Most of these deficiencies could be remedied by extensive testing and revision. The matter of open texture

Table 1. Bugs Arising from Knowledge Programming

Type of Problem	Source of Problem	Manifestation
1. Excess generality	Special cases overlooked	Good rule occasionally produces bad effects
2. Excess specificity	Generality undetected	Rules fail to cover enough cases
3. Concept poverty	Useful relationship not detected and exploited	Limited power and capability of system
4. Invalid knowledge	Misstatement of facts or approximations	Expert's expectations violated
5. Ambiguous knowledge	Implicit dependencies not adequately articulated	Conflicts arise in some situations about what is best to do
6. Invalid reasoning	Programmer incorrectly transforms knowledge	Knowledge programmer's expectations violated
7. Inadequate integration	Dependencies among multiple pieces of advice actually incompletely integrated	Rejected action alternatives satisfy more criteria than selected action does.
8. Limited horizon	Consequences of recent past or probable future events not exploited	Judgmental logic seems static, not sensitive to changing or foreseeable situations
9. Egocentrity	Little attention paid to probable meaning of other's actions	No apparent adaptation of one's behavior to exploit knowledge of other's plans

Source: Hays-Roth, Klahr, and Mostow, 1985.

predicates, however, has a deeper conceptual problem.

The scheme TOTO uses to bring meaning to open texture predicates is not without problems. Specifically, the concepts of "reasonableness" and "willful and wanton misconduct" proved to be problematical. The process of gradual refinement narrows the meaning of these concepts into operational terms, yet to a degree is based on the judgment of the user. The expertise guiding the knowledge base is valid, and legal expertise is not required of the user. It is the ranking of confidence to case facts by the user that requires discretion. For example in the willful and wanton misconduct module, the user may be queried as follows (the user can input any number from 1 to 99):

Did the defendant Jane Smith have the ability to avert injury to the plaintiff Duck Jones, by exercising reasonable care?

Rank your response below.

No ability	Little ability	Some ability	Great ability
1	25	75	99

And next:

Was there an omission of care by Jane Smith to avert an injury to Dick Jones when the threat of injury was apparent?

Rank your confidence in the truth of this statement.

No	Not for sure	Quite sure	Yes
1	25	75	99

In each case user judgment is required to gather case facts. The method was implemented to provide analysis beyond yes/no responses.

The difficulty in bringing meaning to open texture predicates is not unique to expert system development. The problem is identical to decision making by legal experts. For example, when attorneys and judges assess "reasonable conduct," there is no discrete formula to guide the process. Judgment is required to refine how legal concepts relate to conditions surrounding a case. The process implemented in TOTO refines the meaning of vague concepts incrementally based on the gathering of information. Since the goal of the system is to identify key case issues, the focus is on whether TOTO identifies key elements of the concepts.

In the civil arena the determination of negligence is based on the "more likely than not" rule. This means that the determination of negligence is based on the

preponderance of evidence rather than "beyond a doubt" as in criminal law. TOTO attempts to weigh case conditions to create a balance of evidence which will favor either the plaintiff or the defendant. The evidence is gathered based on TOTO's reasoning, yet the user is sometimes required to supply judgment on case elements. The use of the refinement process in conjunction with confidence factors serves to approximate the process that a legal expert may determine what "reasonable conduct" is. This process is obviously a gross implication in comparison to expert legal decision making.

When the system assesses for comparative negligence, a value is given indicating the degree of negligence for which the defendant is responsible. Thus, if the defendant is found negligent and the plaintiff contributed to the injury, the degree of negligence is reduced by a percentage. TOTO reports a discrete number from 0 to 99 indicating the defendant's percentage of negligence. This number should be viewed as a guideline only and is precisely calculated because of the way the software computes mathematics. This degree of negligence could be softened by implementing fuzzy set techniques to result in statements such as, "The defendant is slightly negligent." In civil law, however, there is an actual percentage that is determined by the proceedings. Therefore, the averages of the confidence rankings for

comparative negligence queries were used to produce the numeric result. These are only estimations based on the user's responses and must be viewed as generalizations.

Summary and Conclusions

Summary

Providers of recreation need to know what negligent conduct is. In order to understand the legal decision-making process that determines negligence, one must enter into the civil arena as a defendant in a suit. This ex post facto understanding is of marginal value because an injury has already occurred. There are legal, economic, and ethical motivations for recognizing negligent conditions and remedying them prior to injury.

A knowledge based system was developed to model the decision-making process litigants use to determine if negligence exists prior to entering the civil arena. The program TOTO focuses on assessing potential negligent conditions of the land for defendants that are private individuals, public agencies, or proprietary operations. The overall goal of the system is to aid the user in identifying key elements in a case (real or hypothetical) that determine the potential for negligence. TOTO assesses negligence as well as legal defense to negligence and reports the results to the user.

In order to meet these goals, the following objectives were stated:

1. To provide a systematic means to evaluate legal decision making in recreation liability cases. To understand the problem-solving task.

2. To construct and evaluate a knowledge based system that is theoretically and practically valid.

3. To create extensive explanation facilities in the system to enhance understanding of the problem-solving task by the end user.

These objectives were met in varying degrees.

First objective. The first objective was, in general, satisfied. The software is a systematic model of potential decision-making processes in negligence cases. The decision-making processes is disclosed when the user interacts with the system. Since the reasoning of TOTO is not static, the evaluation of the decision making occurs after a session when one views the line of reasoning report.

Understanding the problem-solving task is the basis for constructing the system. Here the task is diagnostic, and requires two levels of reasoning. The first level is based on rules of law, civil, and statutory interpretations, and legal rule of thumb. The second level, bringing meaning to open texture

predicates, is more difficult in that there is little theoretical basis for doing so. This work does not presume to provide a theoretical basis, but provides a basis for understanding the difficulties of the problem-solving task.

Second objective. The second objective was met given the developmental level of TOTO as a research prototype. The system successfully identifies key issues of a case and makes a rough judgment as to the existence of negligence and defenses. Its performance, however, is fragile in that it makes mistakes. This is due to three major reasons:

1. Limited testing and revision of code: Time constraints limited the amount of evaluation of the system performance. The specific limitations of performance are manifest as items 1, 4, 6, and 7 in Table 1 (as discussed earlier). Some areas of the knowledge base are subsequently more robust than others.

2. The difficulty of bringing meaning to legal concepts that are contextual and nebulous: The approach taken to address open texture predicates has no theoretical basis and requires judgment by the user.

Third objective. The last objective was met in part. The software shell that TOTO operates within has facilities to explain the behavior of the system. User

session reports and line of reasoning reports can be produced automatically. The user may also stop during a session to view the basis for the current reasoning. These explanation facilities, however, do not provide the user with advice on how to assess a question TOTO poses. It was intended that at any point in a session, the user could ask for help by simply pressing the "EXPLAIN" button. Programming this feature is not difficult, yet is very time consuming. For each state of fact, text would be entered that could be called by the user. This would mean entering up to three hundred "explain" files. This was not achieved due to the time needed to correct the problems encountered in programming the knowledge base.

Conclusions

The modeling of decision making in recreation law via knowledge base programming was an exploratory pursuit. This exploration yields conclusions that manifest possibilities rather than facts.

The expert system approach is a viable too for modeling the legal assessment of negligence and other types of recreation law. The ability of a system to identify key legal issues and make recommendations is new in the field of recreation. This research demonstrates

that the technique is feasible with no great expense or extensive background in computer science.

The method is also a viable means of augmenting risk management strategies. A fully developed system could aid providers of recreation services in determining real or hypothetical negligence. Thus economic, legal, and ethical benefits would ensue.

The knowledge base of the system is readily modifiable. This feature yields the potential for exploring how hypothetical or real changes in the law may impact the assessment of negligence. This ability would enhance the ability to assess the impacts of changes is in civil and statutory law and the subsequent impact upon recreation providers.

The last conclusion is that there is weak theoretical basis for bringing meaning to open texture predicates. For example, the determination of what is reasonable is rooted in the context of the situation. Van der Smissen (1990), has suggested that the situational elements of activity, environmental conditions, and the participants impact the assessment of what is reasonable. The final assessment is by a jury of laymen. Attempts to emulate this type of determination with the expert system approach are simplistic, yet may hold promise as a research tool to disclose the nature of this decision making.

Limitations

The major limitation of this study is the incomplete testing of the knowledge base. Although the goal of the research was not to complete a fully implemented system, doing so would have shed light on a wider array of problems and possibilities of the approach. This incomplete testing resulted in fragility of the system that may be expected at the research prototype stage.

Another limitation of the study is the implementation of only one strategy to bring meaning to open texture predicates. This is a result of undertaking a problem that was too broad and the limitations of the expert system shell selected. By focusing on the problem of open texture predicates a deeper understanding of the problem would have resulted. The expert system shell selected was suitable for the easy programming tasks, but not for the difficult ones. The accessibility and price of the shell were primary considerations for its selection. Perhaps greater attention to assessing knowledge representations and inference strategies would yield improved performance.

Recommendations for Further Study

The limitation of this study imply avenues for further research. The structure implemented in the system should be fully developed and tested to enable a

complete assessment of the validity and reliability of the approach. This could be achieved by further formal testing and field testing by practitioners. Implementation in the field would provide an opportunity to assess the usefulness of the approach as perceived by recreation professionals.

Research to develop and analyze new approaches to dealing with open texture predicates is in order. As a fundamental limitation of this system, open texture predicates deserve focused attention. This could be driven by thorough analysis of legal theory and artificial intelligence techniques.

Another avenue for research is the exploration of emerging artificial intelligence methods to study legal decision making. Machine learning algorithms and neural networks may hold promise in understanding the dynamics of bringing meaning to open texture predicates. These methods could be utilized to extensively examine facts of thousands of negligence cases to disclose latent variables, or patterns that impact legal decision making.

APPENDIX A

TEST CASE 1

Line of Reasoning Report for: "tort.KNB" 08/16/1990 01:45:20 P.M.

The following goal was pursued :
Setup
The following ***string*** fact was obtained :
Today's date = True
string = "8/16/90"
The following ***string*** fact was obtained :
Plaintiff's Name = True
string = "Robbin Droppings"
The following ***string*** fact was obtained :
Defendant's Name = True
string = "Phil Dirt"
The following ***string*** fact was obtained :
Agency or firm name = True
string = "Phil Dirt's Golf Club"
The following *Attribute-Value* fact was obtained :
Activity
Golf = True
RULE: to select activity fired.
As a result the following **conclusion** was reached :
Know activity1 = True
RULE: for setup fired.
As a result the following **conclusion** was reached :
Setup = True
The following goal was pursued :
Sum
The following *Attribute-Value* fact was obtained :
Permission
Yes = True
The following *Attribute-Value* fact was obtained :
The premises
is(are) owned by a private interest = True
RULE: To determine landholder type fired.
As a result the following **conclusion** was reached :
Private = True
The following *Attribute-Value* fact was obtained :
Defendant
leases the premises = True
The following **simple fact** was obtained :
Defendant is in actual control of the premises = True
The following **simple fact** was obtained :
Land conditions are managed by the defendant or an employee = True
RULE: To determine private control fired.

As a result the following **conclusion** was reached :
Control Private = True
As a result the following **conclusion** was reached :
Assessed Defendant = True
The following **simple fact** was obtained :
Defendant is a business = True
The following **simple fact** was obtained :
Defendant charges fee to enter premises = True
RULE: to assess proprietorship fired.
As a result the following **conclusion** was reached :
Proprietorship = True
The following **simple fact** was obtained :
Plaintiff expressly invited = True
The following **simple fact** was obtained :
Plaintiff paid a fee to enter prem = True
RULE: for invitee fired.
As a result the following **conclusion** was reached :
Invitee = True
As a result the following **conclusion** was reached :
licensee = False
As a result the following **conclusion** was reached :
trespasser = False
The following *Attribute-Value* fact was obtained :
issue
is of reasonableness = True
RULE: ***META*RULE** to determine ordinary type invitee fired.
As a result the following **conclusion** was reached :
assess for ordneg = True
RULE: ***META*RULE** to assess plaintiff fired.
As a result the following **conclusion** was reached :
Plaintiff isa player = True
As a result the following **conclusion** was reached :
Assessed Plaintiff = True
RULE: ***META*RULE** Burden of Proof fired.
As a result the following **conclusion** was reached :
Assessed Duty = True
As a result the following **conclusion** was reached :
Duty = True
The following *Attribute-Value* fact was obtained :
The defendant
Type 2 = True
RULE: to determine expert knowledge fired.
As a result the following **conclusion** was reached :
Expert knowledge CF = 100
The following **simple fact** was obtained :
adopted written std = True

The following **simple fact** was obtained :
The industry standards are certain. = True
The following **simple fact** was obtained :
The industry standards are uniform. = True
The following **simple fact** was obtained :
The industry standards are well known and obvious. = True
RULE: for industry standard fired.
As a result the following **conclusion** was reached :
Industry standard = True
RULE: Burden of Proof fired.
As a result the following **conclusion** was reached :
Standard exists = True
The following **simple fact** was obtained :
Def met standard for expert knowledge CF = 43
RULE: to meet standard expert knowledge fired.
As a result the following **conclusion** was reached :
Standard = True
RULE: ***MET*ARULE** to determine neg type to Proceed fired.
As a result the following **conclusion** was reached :
Proceed = True
The following **simple fact** was obtained :
D inspects CF = 67
The following **simple fact** was obtained :
D repairs CF = 45
The following **simple fact** was obtained :
D removes CF = 46
The following **simple fact** was obtained :
warning = False
The following **simple fact** was obtained :
Instruction = False
RULE: get ordneg facts fired.
As a result the following **conclusion** was reached :
have data = True
RULE: to have ordneg fired.
As a result the following **conclusion** was reached :
ordneg = True
The following **simple fact** was obtained :
Def should anticipate CF = 100
The following **simple fact** was obtained :
Injuries have occurred CF = 66
RULE: ***MET*ARULE** to avoid breach deformity fired.
As a result the following **conclusion** was reached :
there is ordinary breach = True
The following **simple fact** was obtained :
the plaintiff suffered actual physical harm = True
The following *Attribute-Value* fact was obtained :

Injury occurred
upon the defendants premises = True
RULE: defs prem fired.
As a result the following **conclusion** was reached :
Injury in space = True
The following **simple fact** was obtained :
the gravity of this harm is substantiated by a physician = True
RULE: to determine injury fired.
As a result the following **conclusion** was reached :
Injury valid = True
The following *Attribute-Value* fact was obtained :
Cause
Type A = True
The following **simple fact** was obtained :
injury would not have occurred but for conduct = True
The following **simple fact** was obtained :
conduct coterminous with injury = True
The following **simple fact** was obtained :
conduct contact with injury = True
RULE: for Cause in fact fired.
As a result the following **conclusion** was reached :
Causation f = True
As a result the following **conclusion** was reached :
Cause in fact = True
RULE: ***MET*ARULE** to find cause topology fired.
As a result the following **conclusion** was reached :
Causation = True
RULE: for liability ordneg fired.
As a result the following **conclusion** was reached :
Liability ordneg = True
RULE: output ordneg fired.
As a result the following **conclusion** was reached :
Page one response = True
The following numeric fact was obtained :
Months since alleged injury = True
Value = 13.00
The following numeric fact was obtained :
Age = True
Value = 32.00
RULE: to legitimize assumption fired.
As a result the following **conclusion** was reached :
AssumoRisk Potential = True
The following **simple fact** was obtained :
Plaintiff signed a waiver or signed release to accept risks = True
The following **simple fact** was obtained :
Language of the waiver is unambiguous = False

RULE: to sum fired.
As a result the following **conclusion** was reached :
Sum = True

APPENDIX B

TEST CASE 2

Line of Reasoning Report for: "tort.KNB" 01/26/1991 02:15:55 P.M.

The following goal was pursued :
Setup
The following ***string*** fact was obtained :
Today's date = True
string = "11-8-90"
The following ***string*** fact was obtained :
Plaintiff's Name = True
string = "Fred Nugent"
The following ***string*** fact was obtained :
Defendant's Name = True
string = "Edward Maloney"
The following ***string*** fact was obtained :
Agency or firm name = True
string = "MI DNR"
The following Attribute-Value fact was obtained :
Activity
Swimming = True
RULE: to select activity fired.
As a result the following **conclusion** was reached :
Know activity1 = True
RULE: for setup fired.
As a result the following **conclusion** was reached :
Setup = True
The following goal was pursued :
Sum
The following Attribute-Value fact was obtained :
Permission
Yes = True
The following Attribute-Value fact was obtained :
The premises
is(are) owned by local, county, state or federal government = True
RULE: To determine landholder type fired.
As a result the following **conclusion** was reached :
Public = True
The following **simple fact** was obtained :
Defendant manages the premises in the public trust = True
The following Attribute-Value fact was obtained :
Defendant is
the enterprise administrator = True
RULE: ***METARULE*** To determine public control fired.
As a result the following **conclusion** was reached :
Control Public = True
The following **simple fact** was obtained :
Defendant is a business = False
The following **simple fact** was obtained :
Plaintiff no business transaction = True

The following simple fact was obtained :
No monetary transaction occurred for recreation = True
RULE: for licensee fired.
As a result the following conclusion was reached :
licensee = True
As a result the following conclusion was reached :
Invitee = False
As a result the following conclusion was reached :
trespasser = False
The following Attribute-Value fact was obtained :
issue
is of willfull and wanton misconduct = True
RULE: ***META*RULE** to determine neg type to Proceed fired.
As a result the following conclusion was reached :
Proceed = True
RULE: to determine willwant for no invitee fired.
As a result the following conclusion was reached :
assess for willwant = True
RULE: ***META*RULE** to assess plaintiff fired.
As a result the following conclusion was reached :
Plaintiff isa player = True
As a result the following conclusion was reached :
Assessed Plaintiff = True
The following simple fact was obtained :
Defendant participates, ratified, condones tortious act = True
The following simple fact was obtained :
Negligence arose from hiring, = False
RULE: to asses public administrator fired.
As a result the following conclusion was reached :
Administrator not responsible = True
RULE: ***META*RULE** to make agency defendant fired.
As a result the following conclusion was reached :
Identified defendant = True
As a result the following conclusion was reached :
Def is
Agency at large = True
As a result the following conclusion was reached :
Assessed Defendant = True
RULE: ***META*RULE** Burden of Proof fired.
As a result the following conclusion was reached :
Assessed Duty = True
As a result the following conclusion was reached :
Duty = True
The following simple fact was obtained :
D had knowledge CF = 100
The following simple fact was obtained :
D had ability to avoid CF = 70
The following simple fact was obtained :

D's omission CF = 60
The following simple fact was obtained :
D Conduct shows intent CF = 0
The following simple fact was obtained :
D Conduct shows indifference CF = 90
RULE: to assess intent or indifference fired.
As a result the following conclusion was reached :
lorD = True
RULE: for willful wanton misconduct fired.
As a result the following conclusion was reached :
assessed willwant facts = True
RULE: to math1 willwant facts fired.
As a result the following conclusion was reached :
do math1 = True
RULE: to math2 willwant facts fired.
As a result the following conclusion was reached :
do math2 = True
RULE: to pick wilwant math formula1or2 fired.
As a result the following conclusion was reached :
Have value = True
RULE: to accept Wilwant fired.
As a result the following conclusion was reached :
willful and wanton misconduct by the defendant = True
The following simple fact was obtained :
the plaintiff suffered actual physical harm = True
The following Attribute-Value fact was obtained :
Injury occurred
upon the defendants premises = True
RULE: defs prem fired.
As a result the following conclusion was reached :
Injury in space = True
The following simple fact was obtained :
the gravity of this harm is substantiated by a physician = True
RULE: to determine injury fired.
As a result the following conclusion was reached :
Injury valid = True
The following Attribute-Value fact was obtained :
Cause
Type A = True
The following simple fact was obtained :
injury would not have occurred but for conduct = True
The following simple fact was obtained :
conduct coterminous with injury = True
The following simple fact was obtained :
conduct contact with injury = True
RULE: for Cause in fact fired.
As a result the following conclusion was reached :
Causation f = True
As a result the following conclusion was reached :

Cause in fact = True
RULE: ***META*RULE** to find cause topology fired.
As a result the following **conclusion** was reached :
Causation = True
RULE: for liability grosneg fired.
As a result the following **conclusion** was reached :
Liability grosneg = True
RULE: output grosneg fired.
As a result the following **conclusion** was reached :
Page one response = True
The following numeric fact was obtained :
Months since alleged injury = True
Value = 15.00
The following **simple fact** was obtained :
The plaint contributes = True
The following **simple fact** was obtained :
P Conduct CF = 69
The following **simple fact** was obtained :
P knowledge CF = 75
The following **simple fact** was obtained :
P ability to avoid CF = 83
The following **simple fact** was obtained :
P omission CF = 90
RULE: for comparative negligence weight fired.
As a result the following **conclusion** was reached :
Comparative negligence assessed = True
RULE: for existence of comparative negligence fired.
As a result the following **conclusion** was reached :
CN exists = True
RULE: to invoke comparative negligence fired.
As a result the following **conclusion** was reached :
Partial Liability = True
As a result the following **conclusion** was reached :
Page two response = True
RULE: to sum fired.
As a result the following **conclusion** was reached :
Sum = True

APPENDIX C

TEST CASE 3

Line of Reasoning Report for: "tort.KNB" 08/23/1990 01:22:03 P.M.

The following goal was pursued :
Setup
The following ***String*** fact was obtained :
Today's date = True
String = "8-23-90"
The following ***String*** fact was obtained :
Plaintiff's Name = True
String = "Thomas Rhude"
The following ***String*** fact was obtained :
Defendant's Name = True
String = "Bud Jordahl"
The following ***String*** fact was obtained :
Agency or firm name = True
String = "Bud's Gravel Co."
The following *Attribute-Value* fact was obtained :
Activity
Fishing = True
RULE: to select activity fired.
As a result the following conclusion was reached :
Know activity1 = True
RULE: for setup fired.
As a result the following conclusion was reached :
Setup = True
The following goal was pursued :
Sum
The following *Attribute-Value* fact was obtained :
Permission
No = True
The following *Attribute-Value* fact was obtained :
The premises
is(are) owned by a private interest = True
RULE: To determine landholder type fired.
As a result the following conclusion was reached :
Private = True
The following *Attribute-Value* fact was obtained :
Defendant
is owner of the premises = True
The following simple fact was obtained :
Defendant is in actual control of the premises = True
The following simple fact was obtained :
Land conditions are managed by the defendant or an employee = True
RULE: To determine private control fired.

As a result the following conclusion was reached :
Control Private = True
As a result the following conclusion was reached :
Assessed Defendant = True
RULE: for Trespasser fired.
As a result the following conclusion was reached :
trespasser = True
As a result the following conclusion was reached :
Invitee = False
As a result the following conclusion was reached :
licensee = False
The following *Attribute-Value* fact was obtained :
issue
is of reasonableness = True
RULE: to determine willwant for no invitee fired.
As a result the following conclusion was reached :
No action = True
A CYCLE command was performed.
The following goal was pursued :
Sum
The following *Attribute-Value* fact was obtained :
issue
is of willfull and wanton misconduct = True
RULE: to determine willwant for no invitee fired.
As a result the following conclusion was reached :
assess for willwant = True
RULE: ***META*RULE** to determine neg type to Proceed fired.
As a result the following conclusion was reached :
Proceed = True
RULE: ***META*RULE** to assess plaintiff fired.
As a result the following conclusion was reached :
Plaintiff isa player = True
As a result the following conclusion was reached :
Assessed Plaintiff = True
RULE: ***META*RULE** Burden of Proof fired.
As a result the following conclusion was reached :
Assessed Duty = True
As a result the following conclusion was reached :
Duty = True
The following *Attribute-Value* fact was obtained :
Trespass
was frequent = True
RULE: to determine trespasser type fired.
As a result the following conclusion was reached :
Have trespass type = True
The following simple fact was obtained :
D is aware of frequent intrusion in a specific area = True

The following simple fact was obtained :
active operations creates risk for bodily harm to T = True
The following simple fact was obtained :
D not warn T of artificial conditions that create the danger = True
The following simple fact was obtained :
D knows that conditions will not be discovered by T = True
RULE: for Trespasser Breach for frequent trespasser fired.
As a result the following conclusion was reached :
Assessed Plaintiff = True
As a result the following conclusion was reached :
trespasser1 = True
As a result the following conclusion was reached :
willful and wanton misconduct by the defendant = True
The following simple fact was obtained :
the plaintiff suffered actual physical harm = True
The following *Attribute-Value* fact was obtained :
Injury occurred
upon the defendants premises = True
RULE: defs prem fired.
As a result the following conclusion was reached :
Injury in space = True
The following simple fact was obtained :
the gravity of this harm is substantiated by a physician = True
RULE: to determine injury fired.
As a result the following conclusion was reached :
Injury valid = True
The following *Attribute-Value* fact was obtained :
Cause
Type C = True
The following simple fact was obtained :
Intervening cause was foreseeable = True
RULE: for Proximate Cause intervening cause fired.
As a result the following conclusion was reached :
Causation i = True
As a result the following conclusion was reached :
PC foreseeable = True
RULE: ***META*RULE** to find cause topology fired.
As a result the following conclusion was reached :
Causation = True
RULE: for liability grosneg fired.
As a result the following conclusion was reached :
Liability grosneg = True
RULE: output grosneg fired.
As a result the following conclusion was reached :
Page one response = True
The following numeric fact was obtained :

Months since alleged injury = True
Value = 14.00
The following simple fact was obtained :
The plaint contributes = True
The following simple fact was obtained :
P Conduct CF = 87
The following simple fact was obtained :
P knowledge CF = 73
The following simple fact was obtained :
P ability to avoid CF = 52
The following simple fact was obtained :
P omission CF = 96
RULE: for comparative negligence weight fired.
As a result the following conclusion was reached :
Comparative negligence assessed = True
RULE: for existence of comparative negligence fired.
As a result the following conclusion was reached :
CN exists = True
RULE: to invoke comparative negligence fired.
As a result the following conclusion was reached :
Partial Liability = True
As a result the following conclusion was reached :
Page two response = True
RULE: to sum fired.
As a result the following conclusion was reached :
Sum = True

APPENDIX D

EDITED KNOWLEDGE BASE IN TOTO

TITLE TOTO

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
 SETUP RULES
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

RULE for setup
IF PAINT TOTO.PICT
AND ASK Today's date
AND ASK Plaintiff's Name <>''
AND ASK Defendant's Name <>''
AND ASK Agency or firm name <>''
AND Know activity1
THEN Setup


\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
CONTROL RULE CONTROL RULE CONTROL RULE
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

RULE to sum
IF Page one response
AND Page two response
OR NOT Page two response
THEN Sum
AND FILE LORR line o reasoning
||||||||||||||||||||||||||||||||||||||||||

RULE output ordneg
IF Liability ordneg
THEN Page one response

RULE output grosneg
IF Liability grosneg
THEN Page one response

RULE output no duty
IF No Liability ordneg
OR No Liability grosneg
AND NOT Duty
THEN Page one response
AND DISPLAY No burden duty
```

RULE output no std
IF No Liability ordneg
AND NOT Standard
THEN Page one response
AND DISPLAY No burden std

RULE output no ordbreach
IF No Liability ordneg
AND NOT there is ordinary breach
THEN Page one response
AND DISPLAY No burden ordbreach

RULE output no grossbreach
IF No Liability grosneg
AND NOT willful and wanton misconduct by the defendant
THEN Page one response
AND DISPLAY No burden grossbreach

RULE output no injury
IF No Liability ordneg
OR No Liability grosneg
AND NOT Injury valid
THEN Page one response
AND DISPLAY No burden injury

RULE output no cause
IF No Liability ordneg
OR No Liability grosneg
AND NOT Causation
THEN Page one response
AND DISPLAY No burden cause

\\\
BIG **RULES**
\\\

RULE for no liability ordneg
IF assess for ordneg
AND NOT Duty
OR NOT Standard
OR NOT there is ordinary breach
OR NOT Injury valid
OR NOT Causation
THEN No Liability ordneg

RULE for liability ordneg
IF assess for ordneg
AND Duty
AND Standard
AND there is ordinary breach
AND Injury valid
AND Causation
THEN Liability ordneg

RULE for no liability grosneg
IF Proceed
AND assess for willwant
AND NOT Duty
OR NOT willful and wanton misconduct by the defendant
OR NOT Injury valid
OR NOT Causation
THEN No Liability grosneg

RULE for liability grosneg
IF Proceed
AND assess for willwant
AND Duty
AND willful and wanton misconduct by the defendant
AND Injury valid
AND Causation
THEN Liability grosneg

RULE to reject trespasser ordneg
IF trespasser
AND issue\ is of reasonableness
THEN Reject
AND DISPLAY tres no ordneg

\\\
Implement Defenses
\\\

RULE to invoke statute of limitation
IF Liability ordneg
OR Liability grosneg
AND Statute of limitation imposed
THEN No liability
AND Page two response
AND DISPLAY stat lim

RULE to invoke rec use statute
IF Liability ordneg
AND invoke rec use statute
THEN No liability
AND Page two response
AND DISPLAY rec use

RULE to invoke valid waiver
IF Liability ordneg
AND valid waiver
THEN No liability
AND Page two response
AND DISPLAY waiver

RULE to invoke comparative negligence
IF Liability grosneg
AND CN exists
THEN Partial Liability
AND LL:=100-CONF(CN)
AND Page two response
AND DISPLAY compneg

RULE to acuate comparative negligence 1 !!!!!
IF CONF (LL)> 50
THEN CONF LL=50

RULE to invoke Assumption of risk
IF Liability grosneg
AND Assumption of risk
THEN Partial Liability
AND DISPLAY assrisk
AND Page two response

\\
DUTY
\\

RULE *METARULE* Burden of Proof-Duty
IF Control Private
OR Control Public
AND Assessed Plaintiff
AND Assessed Defendant
THEN Assessed Duty
AND Duty

\\
Determine Defendant(s)
\\

RULE *META*RULE to make agency defendant
IF Board member not responsible
OR Administrator not responsible
OR Employee not responsible
OR Volunteer not responsible
THEN Identified defendant
AND Def is \ Agency at large
AND Assessed Defendant

RULE *META*RULE to make individual responsible
IF Public
AND Indiv defendant\ Board member
OR Indiv defendant\ Administrator
OR Indiv defendant\ Employee
OR Indiv defendant\ Volunteer
THEN Identified defendant
AND Def is \ Agency and Individual
AND Assessed Defendant

\\
Classify Players
\\

RULE *META*RULE to assess plaintiff
IF Invitee
OR licensee
OR trespasser
THEN Plaintiff isa player
AND Assessed Plaintiff

RULE *META*RULE To determine public control
IF Public
AND Defendant manages the premises in the public trust
AND Defendant is \ on the board of directors
OR Defendant is \ the enterprise administrator
OR Defendant is\ an employee
OR Defendant is \ a volunteer
THEN Control Public

RULE To determine landholder type
IF The premises IS owned by a private interest
THEN Private

RULE To determine landholder type
IF The premises IS owned by local, county, state or federal government
THEN Public

RULE To determine private control
IF Private
AND Defendant \ is owner of the premises
OR Defendant \ leases the premises
OR Defendant \ is an independent contractor on the premises
AND Defendant is in actual control of the premises
AND Land conditions are managed by the defendant or an employee
THEN Control Private
AND Assessed Defendant

RULE to assess public board member
IF Control Public
AND Defendant is\ on the board of directors
AND The negligent act is within scope
THEN Board member not responsible
AND Authority for conduct was discretionary

RULE to make board member a player
IF NOT Board member not responsible
THEN Individual defendant
AND Indiv defendant\ Board member

RULE to asses public administrator
IF Control Public
AND Defendant is \ the enterprise administrator
AND NOT Defendant participates, ratified, condones tortious act
OR NOT Negligence arose from hiring,
OR NOT Negligence arose from training
OR NOT Negligence arose from retaining an employee
THEN Administrator not responsible

RULE to make administrator a player
IF NOT Administrator not responsible
THEN Individual defendant
AND Indiv defendant\ Administrator

RULE to assess public individual
IF Control Public
AND Defendant is \ an employee
AND NOT Employee is responsible for tortious act
AND The negligent act is within scope
AND Employee's act was while on duty
THEN Employee not responsible

RULE to make employee a player
IF NOT Employee not responsible
THEN Individual defendant
AND Indiv defendant\ Employee

RULE to assess contractor
IF Control Public
AND Defendant is \ an independent contractor on the premises
AND Tortious condition is created by independent contractor
AND Agency does not have significant control over t*ASK*
OR Agency does not retain supervision !or control over the employees!
THEN Contractor responsible
AND Indiv defendant\ Contractor

RULE to asses volunteer
IF Control Public
AND Defendant is \ a volunteer
AND NOT Volunteer's actions created tortious condition
OR Volunteer's actions created tortious condition
AND The negligent act is within scope
THEN Volunteer not responsible

RULE to make volunteer a player
IF NOT Volunteer not responsible
THEN Individual defendant
AND Indiv defendant \ Volunteer

RULE to assess proprietorship
IF Public
OR Private
AND Defendant is a business
AND Defendant charges fee to enter premises
OR Defendant charges fee for activity on premises
THEN Proprietorship

RULE for invitee
IF Permission \ Yes
AND Control Public
OR Control Private
AND Proprietorship
AND Plaintiff expressly invited
AND Plaintiff paid a fee to enter prem
OR Plaintiff paid a fee for activity
THEN Invitee
AND NOT licensee
AND NOT trespasser

RULE for licensee
IF Control Public
OR Control Private
AND Permission \ Yes
AND Plaintiff no business transaction
AND No monetary transaction occurred for recreation
THEN licensee
AND NOT Invitee
AND NOT trespasser

RULE for minor
IF Age<13
THEN minor

RULE for Trespasser
IF Permission \ No
THEN trespasser
AND NOT Invitee
AND NOT licensee

\\
Standard
\\

RULE to meet standard common knowledge
IF Common Knowledge
THEN Standard

RULE to meet standard expert knowledge
IF Standard exists
AND Expert knowledge
AND Def met standard for expert knowledge
THEN Standard

RULE Burden of Proof-breach
IF Invitee
AND Common knowledge
AND CONF (Common knowledge) >50
AND Industry standard
OR Industry custom
THEN Standard exists

RULE Burden of Proof-breach2
IF Invitee
AND Expert knowledge
AND CONF (Expert knowledge) >50
AND Industry standard
OR Industry custom
THEN Standard exists

RULE to determine common knowledge
IF The defendant \ Type 1
THEN Common Knowledge

RULE to determine expert knowledge
IF The defendant \ Type 2
THEN Expert knowledge

RULE for industry standard
IF adopted written std
AND The industry standards are certain.
AND The industry standards are uniform.
AND The industry standards are well known and obvious.
THEN Industry standard

RULE for industry custom
IF Customs
AND The industry customs are certain.
AND The industry customs are uniform.
AND The industry customs are well known and obvious.
THEN Industry custom

\\\
ordinary or willful and wanton
\\\

RULE ***META*RULE** to determine neg type to Proceed
IF NOT No action
OR assess for ordneg
OR assess for willwant
THEN Proceed

RULE *METARULE* to determine ordinary type invitee
IF Invitee
AND issue \is of reasonableness
THEN assess for ordneg

RULE to determine willwant type invitee
IF Invitee
AND issue \is of willfull and wanton misconduct
THEN assess for willwant

RULE to determine willwant for no invitee
IF licensee
OR trespasser
AND issue\is of willfull and wanton misconduct
THEN assess for willwant

RULE to determine willwant for no invitee
IF licensee
OR trespasser
AND issue \is of reasonableness
THEN No action
AND DISPLAY not actionable
AND FORGET issue
AND CYCLE

\\\
ORDBREACH
\\\

RULE *METARULE* to avoid breach deformity
IF Proceed
AND assess for ordneg
AND ordneg
AND NOT Reasonable
THEN there is ordinary breach

RULE *METARULE* to deform breach
IF Proceed
AND assess for ordneg
AND not ordneg
AND Reasonable
THEN NOT there is ordinary breach

RULE *METARULE* to deform breach
IF Proceed
AND assess for ordneg
AND not ordneg
AND NOT Reasonable
THEN NOT there is ordinary breach

RULE get ordneg facts
IF Invitee
AND D inspects
AND D repairs
OR D removes
OR D clear warning
THEN have data
AND OG :=(CONF(D inspects)+CONF(D repairs)+CONF(D removes):
+CONF(D clear warning))/3

RULE to have ordneg
IF have data
AND CONF(OG) <= 50
THEN ordneg

RULE to reject ordneg
IF have data
AND OG > 50
THEN not ordneg

RULE Failure to warn or instruct
IF warning !or instruction!
OR Instruction
THEN D clear warning
AND CONF (D clear warning):=100

RULE for REASONABILITY
IF Invitee
!AND Probability!
AND Magnitude of risk
AND Burden of alternative conduct
AND CONF(M) >CONF(B)
THEN NOT Reasonable

RULE for UNREASONABILITY
IF Magnitude of risk
AND Burden of alternative conduct
AND CONF (M) < CONF(B)
THEN Reasonable

RULE for foreseeable probability
IF Def should anticipate
AND Injuries have occurred
AND common knowledge
THEN Probability
AND P := (CONF (Def should anticipate)+ CONF (Injuries have occurred):
+ CONF(common knowledge)) /3

RULE for magnitude of risk
IF Probability
AND G
THEN Magnitude of risk
AND M := (CONF(P)+CONF(G)) /2

RULE for Burden of alternative conduct
IF U
AND A !feasibility of alternative!
AND C !relative cost of safer conduct!
AND S !relative utility of safer conduct!
AND aS !relative safety of alternative conduct!
THEN Burden of alternative conduct
AND B := ((CONF (A)+CONF (C)+CONF (S)+CONF (aS)) /4) - CONF (U)

\\
CAUSATION
\\

RULE *META*RULE to find cause topology
IF Causation f
OR Causation u
OR Causation i
THEN Causation

RULE for Cause in fact
IF Cause\ Type A
AND injury would not have occurred but for conduct
AND conduct coterminous with injury
AND conduct contact with injury
OR avoidance of conduct yields injury
THEN Causation f
AND Cause in fact

RULE for Proximate Cause unforeseeable consequences
IF Cause \ Type B
AND consequences of D conduct were foreseeable
AND P was within the foreseeable zone of danger
OR P isa rescuer
THEN Causation u
AND PC foreseeable

RULE for Proximate Cause intervening cause
IF Cause \ Type C
AND Intervening cause was foreseeable
OR Non extraordinary weather conditions or changes
OR Third party negligence
OR Third party criminal conduct
OR P isa rescuer
THEN Causation i
AND PC foreseeable

RULE to determine 3rd party criminal conduct
IF Criminal action by third party involved
AND D conduct exposed P to that risk
THEN Third party criminal conduct

RULE to determine rescuer
IF P was attempting rescue as a result of conduct
THEN P isa rescuer

\\\
INJURY
\\\

RULE to determine injury
IF the plaintiff suffered actual physical harm
AND Injury in space
AND the gravity of this harm is substantiated by a physician
THEN Injury valid

RULE defs prem\adj prem
IF NOT Injury occurred \on premises adjacent to defendants premises
OR Injury occurred \upon the defendants premises
THEN Injury in space

RULE to validify adajacent
IF Injury occurred \on premises adjacent to defendants premises
AND Defendant control of adj premisis
THEN Injury valid

RULE to validify def control of adj prem
IF Defendant leases adjacent premisis
OR Def retains control over land conditions on adjacent prem
AND The hazard in question lies on adjacent premisis
THEN Defendant control of adj premisis

\\
WILLFUL/ WANTON BREACH
\\

RULE for willful wanton misconduct
IF Proceed
AND assess for willwant
AND licensee
OR Invitee
AND D had knowledge
AND D had ability to avoid
AND D's omission
AND lorD
THEN assessed willwant facts

RULE to assess intent or indifference
IF D Conduct shows intent
OR D Conduct shows indifference
THEN lorD

RULE to math1 willwant facts
IF assessed willwant facts
THEN do math1
AND Wilwant := (CONF (D had knowledge) + CONF (D had ability to avoid):
+CONF (D's omission) + CONF (D Conduct shows intent))/4

RULE to math2 willwant facts
IF assessed willwant facts
THEN do math2
AND Wilwant := (CONF (D had knowledge) + CONF (D had ability to avoid):
+CONF(D's omission) + CONF (D Conduct shows indifference))/4

RULE to pick wilwant math formula1or2
IF do math1
OR do math2
THEN Have value

RULE to reject Wilwant
IF Have value
AND CONF (Wilwant) < 50
THEN NOT willful and wanton misconduct by the defendant

RULE to accept Wilwant
IF Have value
AND CONF (Wilwant) >50
THEN willful and wanton misconduct by the defendant

\\
Willwant Trespasser
\\

RULE to determine trespasser type
IF Proceed
AND assess for willwant
AND trespasser
AND Trespass\ was frequent
OR Trespass\ discovered by defendant
OR Trespass\ involves a minor
OR Trespass\ none of the above
THEN Have trespass type

\\
Willwant for normal trespasser
\\

RULE for willful wanton misconduct
IF Proceed
AND assess for willwant
AND Have trespass type
AND Trespass\ none of the above
AND D had knowledge
AND D had ability to avoid !
AND D's omission
AND lorD
THEN assessed willwant facts

RULE to assess intent or indifference
IF D Conduct shows intent
OR D Conduct shows indifference
THEN lorD

RULE to math1 willwant facts
IF assessed willwant facts
THEN do math1
AND Wilwant := (CONF (D had knowledge) + CONF (D had ability to avoid):
+CONF (D's omission) + CONF (D Conduct shows intent))/4

RULE to math2 willwant facts
IF assessed willwant facts
THEN do math2
AND Wilwant := (CONF (D had knowledge) + CONF (D had ability to avoid):
+CONF(D's omission) + CONF (D Conduct shows indifference))/4

RULE to pick wilwant math formula1or2
IF do math1
OR do math2
THEN Have value

RULE to reject Wilwant
IF Have value
AND CONF (Wilwant) < 50
THEN NOT willful and wanton misconduct by the defendant

RULE to accept Wilwant
IF Have value
AND CONF (Wilwant) >50
THEN willful and wanton misconduct by the defendant

\\
willwant for frequent, discovered or minor
\\

RULE for Trespasser Breach for frequent trespasser
IF Have trespass type
AND Trespass\ was frequent
AND D is aware of frequent intrusion in a specific area
AND active operations creates risk for bodily harm to T
AND D not warn T of artificial conditions that create the danger
AND D knows that conditions will not be discovered by T
THEN Assessed Plaintiff
AND trespasser1
AND willful and wanton misconduct by the defendant

RULE for Trespasser Breach 2
IF Have trespass type
AND Trespass\ discovered by defendant
AND D discovers T on the premises
AND D continues conduct that creates risk for injury to T
AND NOT natural conditions on land
AND D knows that hazardous cond will not be discovered by T
AND D did not control elements within control to limit risk
OR D did not warn T of artif cond on the land that create risk
THEN Assessed Plaintiff
AND trespasser2
AND willful and wanton misconduct by the defendant

RULE for Trespasser Breach 3
IF Have trespass type
AND Trespass\ involves a minor
AND minor
AND D knows or has reason to know of T is likely
AND D is aware of bodharm condition to minor T
AND NOT natural conditions on land
AND condition creates risk of bodily harm or death
AND D not control within power to limit risk
THEN Assessed Plaintiff
AND trespasser3
AND willful and wanton misconduct by the defendant

RULE for Landholder natural conditions
IF land is in a natural condition
AND Land has not been altered by D or others
THEN natural conditions on land

\\
DEFENSES
\\

RULE Statute of limitations
IF Months since alleged injury >36
AND Age >18
THEN Assessed Defenses
AND Statute of limitation imposed

RULE rec use statute
IF Control Private
OR Control Public
AND NOT Invitee
AND Plaintiff was on def prem for a rec purpose
AND NOT Social guest
AND NOT Fishing from nav h2o
AND No monetary transaction occurred for recreation
AND a state park
THEN invoke rec use

RULE to determine state park
IF Def prem a MI state park
AND The injury occurred within park boundaries
THEN a state park

RULE to determine fishing exclusion
IF Activity \ Fishing
AND NOT a private lake
AND NOT there are streams entering or leaving the lake
THEN Fishing from nav h2o

RULE for existence of comparative negligence
IF The plaint contributes
AND Comparative negligence assessed
THEN CN exists
AND CN := (CONF(P Conduct)+CONF(P knowledge)+CONF(P ability to avoid):
+CONF(P omission))/4

RULE for comparative negligence weight
IF P Conduct shows indifference
AND P knowledge
AND P ability to avoid
AND P omission
THEN Comparative negligence assessed

RULE for rec activity
IF Know activity1
THEN Plaintiff was on def prem for a rec purpose

RULE DEFENSES Waiver
IF AssumoRisk Potential
AND Plaintiff signed a waiver or signed release to accept risks
OR Plaintiff agreed verbally to accept risks
AND Language of the waiver is unambiguous
AND release includes hazard type in question
THEN Assessed Defenses
AND valid waiver
AND Express assumption of risk
AND D liable for grossneg

RULE to legitimize assumption-o-risk
IF NOT minor
OR NOT Parental consent
THEN AssumoRisk Potential

RULE Expressed assumption of risk
IF AssumoRisk Potential
AND Plaintiff read warning signs prior to activity
AND Plaintiff understood and appreciated the warning
THEN Expressed assumption of risk

RULE Implied assumption of risk
IF AssumoRisk Potential
AND P knows, appreciates and understands existence of the risk
AND P voluntarily entered into the risk situation
AND P conduct manifests consent
THEN Implied assumption of risk

RULE ***META*RULE** DEFENSES assumption of risk
IF Expressed assumption of risk
OR Implied assumption of risk
THEN Assessed Defenses
AND Assumption of risk

APPENDIX E

PORTION OF TOTO'S KNOWLEDGE TREE

Knowledge Base : TORT

Compiled : 07/23/1990 10:43:39 A.M.

1. Setup
From rule : for setup
Uses fact : Know activity1
From rule : to select activity
Asks question : Activity Swimming
Asks question : Activity Boating
Asks question : Activity Fishing
Asks question : Activity Camping
Asks question : Activity Hunting
Asks question : Activity Playground
Asks question : Activity XC Skiing
Asks question : Activity Alpine Skiing
Asks question : Activity Skating
Asks question : Activity Golf

1.1. Sum
From rule : to sum
From rule : Page one response
From rule : output ordneg
Uses fact : Liability ordneg
From rule : for liability ordneg
Uses fact : assess for ordneg
From rule : **METARULE**to determine ordinary type invitee
Uses fact : Invitee
From rule : for invitee
Asks question : Permission Yes
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Uses fact : Proprietorship
From rule : to assess proprietorship
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Uses fact : Private

From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is a business

Asks question : Defendant charges fee to enter premises
Asks question : Defendant charges fee for activity on premises
Asks question : Plaintiff expressly invited
Asks question : Plaintiff paid a fee to enter prem
Asks question : Plaintiff paid a fee for activity
From rule : for licensee
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Asks question : Permission Yes
Asks question : Plaintiff no business transaction
Asks question : No monetary transaction occurred for recreation
From rule : for Trespasser
Asks question : Permission No
Asks question : Issue is of reasonableness
Uses fact : Duty
From rule : **METARULE**Burden of Proof
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public

From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Assessed Plaintiff
From rule : **METARULE**To assess plaintiff
Uses fact : Invitee
From rule : for Invitee

Asks question : Permission Yes
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Uses fact : Proprietorship
From rule : to assess proprietorship
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is a business
Asks question : Defendant charges fee to enter premises
Asks question : Defendant charges fee for activity on premises
Asks question : Plaintiff expressly invited
Asks question : Plaintiff paid a fee to enter prem
Asks question : Plaintiff paid a fee for activity
From rule : for licensee
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public

From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Asks question : Permission Yes
Asks question : Plaintiff no business transaction

Asks question : No monetary transaction occurred for recreation
From rule : for Trespasser
Asks question : Permission No
Uses fact : licensee
From rule : for Invitee
Asks question : Permission Yes
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
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Asks question : The premises owned by a private interest
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Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Uses fact : Proprietorship
From rule : to assess proprietorship
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Uses fact : Private

From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is a business
Asks question : Defendant charges fee to enter premises
Asks question : Defendant charges fee for activity on premises
Asks question : Plaintiff expressly invited
Asks question : Plaintiff paid a fee to enter prem
Asks question : Plaintiff paid a fee for activity
From rule : for licensee
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises

Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Asks question : Permission Yes
Asks question : Plaintiff no business transaction
Asks question : No monetary transaction occurred for recreation
From rule : for Trespasser
Asks question : Permission No
Uses fact : trespasser
From rule : for invitee
Asks question : Permission Yes
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private

From rule : To determine landholder type
Asks question : The premises owned by a private interest
Asks question : Defendant is owner of the premises
Asks question : Defendant leases the premises
Asks question : Defendant is an independent contractor on the premises
Asks question : Defendant is in actual control of the premises
Asks question : Land conditions are managed by the defendant or an employee
Uses fact : Proprietorship
From rule : to assess proprietorship
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Uses fact : Private
From rule : To determine landholder type
Asks question : The premises owned by a private interest
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Asks question : Plaintiff expressly invited
Asks question : Plaintiff paid a fee to enter prem
Asks question : Plaintiff paid a fee for activity
From rule : for licensee
Uses fact : Control Public
From rule : **METARULE**To determine public control
Uses fact : Public
From rule : To determine landholder type
Asks question : The premises owned by local, county, state or federal government
Asks question : Defendant manages the premises in the public trust
Asks question : Defendant is on the board of directors
Asks question : Defendant is the enterprise administrator
Asks question : Defendant is an employee
Asks question : Defendant is a volunteer
Uses fact : Control Private
From rule : To determine private control
Uses fact : Private

APPENDIX F

SAMPLE SESSION REPORTS

Session Report

Session Date: 9-11-90
Plaintiff: Bill Smith
Plaintiff age: 43
Defendant: Tom Mather
Agency or firm: Saginaw County Park System
Defendant is a: Volunteer
Responsibility lies with: Volunteer
Activity type: Swimming
Month since injury: 11
Type of negligence pursued: willful and wanton misconduct

Causation: ? (A) cause in fact
(B) Proximate cause, unforeseeable consequences
(C) Proximate cause, intervening cause

TOTO has determined that there is willful and wanton misconduct by Tom Mather. In this case liability of the defendant is reduced because of Bill Smith's conduct contributed to the injury.

Tom Mather's liability: 50%

SESSION REPORT

Session Date: 8-6-90
Plaintiff: Kerrin O'Brien
Plaintiff age: 23
Defendant: Thord Sundstrom
Agency or firm: Thord's Mountain
Defendant is a: Owner of the premises
Responsibility lies with: Thord Sundstrom
Activity type: Skiing
Month since injury: 7
Type of negligence pursued: Ordinary negligence
Causation: ? (A) cause in fact
(B) Proximate cause, unforeseeable consequences
(C) Proximate cause, intervening cause

In order for legal negligence to exist, the plaintiff Kerrin O'Brien must demonstrate a preponderance of evidence that fulfills basic criteria. These
criteria include:

- a duty by the defendant to act or refrain from acting
- a breach of that duty by the defendant's failure to meet a standard or level of conduct.
- a causal connection between the negligent conduct and the plaintiff's injury.
- Actual injury that is measurable

In this case Kerrin O'Brien demonstrated that the first two elements of negligence exist. In order for there to be negligence there must be a causal link between negligent conduct and the injury. In this case the causal connection has not been demonstrated and thus there is no negligence.

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