

Law as Rules of Behavioural Choice:

An Exploration of Jurisprudential Systems

by

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Introduction

Despite the hundreds of years of development of science, and legal science, the law continues to be inaccessible to most people. It is like the world of Platonic forms. Any description of it is usually tenuous. The Platonic model may have some advantages in the development of the law, since it allows for a mystical authority for a proposition where another rationale can not be found; furthermore a mystical wisdom is ipso facto not questionable. Mysticism has often been used as a camouflage for the exercise of naked power and for the inability to intelligently articulate a complex matter. In 1922 Roscoe Pound made the following observation:

Indeed the everyday work of the courts was never more completely shaped by abstract philosophical ideas than in the nineteenth century when lawyers affected to despise philosophy and analytical jurists believed they had set up a self-sufficient science of law which stood in no need of any philosophical apparatus.(1)

The influence of legislation, which attempted to clearly articulate rules, but without specification of the perspectives from which they might be viewed, has been resisted by the fuzziness of judicial interpretation. Modern studies in hermeneutics now loom over the rules of statutory interpretation and promise a new science which could be applied to judicial dicta, especially in the formulation of jurisprudential systems for computer processing.(2)

This Chapter poses a systemic approach to legal information, to identify the range of perspectives from which the law might be stated and dealt with in various ways. If these dimensions are established, the complexity of the law might be unravelled so that people can see clearly its behavioural mandates and opportunities. Some of the fuzziness of the law has been due to the use of language which has attempted to condense a great deal of information to the limits of human capacities of memory and mental processing. It has also been due to the limited use of paradigms of human intelligence, in particular, the over-reliance on the age old pyramid or hierarchy paradigm. Such a paradigm does not provide for the many viewpoints from which the law will be

considered by people in relation to their daily activities. A paradigm which accommodates the relative perspectives of the human world is required.

Because the law is so complex, loose and abstract, it is like a tangled web. It can not be assumed that rules will be interpreted consistently by all judges, by legal advisors, or by people who can not afford to take legal advice on a common interpretation. The law is uncertain; it might be less uncertain if there is an increased understanding about its uncertainties and the usefulness of these uncertainties. The paradigm of relative perspectives of the human world must be suited to the task of managing information of this nature. In this Chapter, both the historical and modern resources are used to develop the framework of a suitable system.

While any system of legal information is necessarily metaphysical, this does not mean that it must be inaccessible, or that its semantic content is inherently mystical. Legal information can serve as a clear statement of behaviour that is required or permitted, and its legal consequences. This is so even though the basic premise of the legal system is that people are free to do whatever they choose subject to the prohibitions and mandates of the law. With a systemic approach, legal choice can be set out together with all its perspectives so that it may be considered for different purposes. The systemic approach is taken in order to manage the inter-relationship of different views of legal information, and, at the same time, preserve the consistency, stability and flexibility in the application of the law.

If the many paradigms of intelligence which have been distilled in the previous historical chapters, are considered as a whole, it can be seen that, over time, various themes of intelligence wax and wane, both in legal science and in science generally. Predominant recurring paradigms may be stabilizing or homeostatic paradigms, while minor and occasional paradigms may serve incidental, but nevertheless essential, homeostatic or heterostatic purposes. Concepts such as systematization, units, relativity and change are predominant and recurring paradigms. Concepts such as monads are variations on units which suggest a particular form of stabilization of units. This form may be

suitable in some particular intelligent activities but not in others. The picture of human intelligence which can be established longitudinally, as it were, through time, may be turned horizontally and used holistically from time to time. This is the approach taken in this Chapter.

There are multitudes of intelligence paradigms which have not been raised in this thesis which might be useful. The combinatorial explosion which is a potential of human language, is an indication of the bounds and richness of human intelligence. Within this potential lies the scope for human enjoyment of life. The thesis is limited to a selection of significant paradigms, within the range of law and its interaction with science. Both historical and modern resources are used. The collective human intelligence is a natural system which is capable of more effective organization and operations. For its own survival, human intelligence now needs to adjust to the heterostatic pressures for change. The resources of intelligence may be consciously systematized, so that they can be used more appropriately, especially in the tasks of providing a more effective legal system. The legal system is the self-discipline of collective human intelligence.

Some intelligence paradigms may be used, both in the design of a system of human intelligence, and as the content of the system. In metaphysical domains, ideas may be duplicated so that they can be used in various ways. This Chapter poses a design of a system of intelligence, called SURMET (SURvival METAsystem). The design uses predominant, stable paradigms of intelligence as a framework for cataloguing and processing information. SURMET is a decision-making system, which is developed through a systemic approach to legal information. It can be used as a framework for legal choices so that these choices may be understood and evaluated relatively, and selections may be made in the best interests of human survival. SURMET incorporates both ethical and cognitive aspects of legal choice. It is posed, not as the form of codification of legal choice, but as a suitable framework for developing a codification of legal choice.

In order to found a framework for the development of SURMET, a paradigm of an intelligent or reasonable person, the client paradigm, is outlined. This common individual paradigm is used as the basis for a collective intelligence system. The client paradigm encapsulates the intelligent activity of processing information as a resource, for decision-making in the course of human survival. SURMET is constructed architectonically, as a metasystem of practical reasoning. The system may be regarded as a Platonic system of forms or ideas. However, the forms attain perfection only to the extent that they achieve the survival goals of the system. The resources of modern systems science are also used in the development of SURMET.

The Chapter deals firstly with the Client Paradigm. The resources of modern systems science which are used to develop the client paradigm into a framework for informed legal choice are then set out. Further development of SURMET then proceeds through the use of major paradigms of intelligence, and the analysis of legal information.

Apart from providing an outline of SURMET, this Chapter also suggests a course for further development of the system. This course contains two approaches: firstly, the use of a welfare equity, in administrative decision-making, and, secondly, the use of a minimax strategy, especially in legal choices which apply to the business world. In order to develop a welfare equity, the nature, principles and maxims of equity are employed to serve social welfare. For the development of a minimax strategy, in the legal decision-making of business people, game theory is considered. Social welfare and business interests might be regarded as the two extremes which the legal system must accommodate. With a common framework like SURMET, it is possible to see how these extremes can be reconciled.

The Client Paradigm

In developing a behavioural view of the law, the concerns of the study of psychology are pertinent. Psychology is the study of human behaviour, including mental behaviour. The discipline of psychology emerged as a field of study in the nineteenth century,

following Charles Darwin's studies of survival, evolution and emotion. The first psychological laboratory was established by Wilhelm Wundt in 1879 in Leipzig, Germany. Charles Darwin was predominantly concerned with the processes of natural selection, the choices of Nature. Psychology accommodated many earlier philosophical studies, reaching back to Anaximenes' philosophy of pneuma, the primary substance of all existences, which, in its pure form, is thought. At first, psychology was defined as the science of mental life.(3) Later it was redefined as the study of behaviour.(4) Through the study of human behaviour, including mental behaviour, the discipline of psychology explores the processes of natural selection and, within natural selection, the scope for human self-determination and informed human decision-making. It therefore pertains to human choice. The study of human behaviour includes the study of human choice.

In the twentieth century, psychological theory was fashioned by a number of key concepts, which are identified as follows:

1. human signalling, stimulus-response sequences, and communication
2. consciousness, perception, instinct, intuition, memory, learning, experience, habit, conceptual organisation, cognition, tension, stress, emotion, and values
3. motivation, goal-directed behaviour, needs and wants
4. heredity, environment and human development
5. personality, roles, human relationships, conflict, social functioning and attitudes
6. group behaviour and coordination
7. human intelligence, conscience and morality

These key concepts may be organised systemically to constitute a Darwinian paradigm of human psychology which forms the framework of the client paradigm. Thus, human beings have needs and wants

which they must satisfy. The attainment of satisfaction of certain needs and wants is the goal which motivates and directs individual behaviour. In order to achieve this goal, the individual employs intelligence, tension and stress. Through human capacities for consciousness, instinct, perception, learning, experience, habit, intuition and memory, the individual devises a conceptual organisation which produces cognition or understanding about the achievement of goals. This understanding is used to facilitate the attainment of satisfaction. Techniques for achieving specific goals include appropriate signalling, stimulus-response sequences, communication, roles, values, attitudes, personality and human development. Through coordinated human activity, human relationships and social functioning, goal attainment may be optimized. Stable human relationships, without conflict, may permit the learning of behaviour which will reliably achieve goals. These methods and techniques themselves may be needed, wanted, and, to some extent, may be adopted as goals. Further psychological theory may be regarded as the particularisation of this survival paradigm.

In regard to each of the elements of the client paradigm, the law may be seen as:

1. the subject of consciousness, perception, memory, learning, experience, habit, conceptual organisation, cognition, emotion, values, intuition, and even as human instinct;
2. related to the satisfaction of needs and wants, and to the formulation of goals. Law may restrain satisfaction and goal achievement, or it may provide opportunities for satisfaction and the extension of potential goals. Law may itself be a method or technique for goal attainment and the satisfaction of needs and wants. As such the law may be involved in human motivation;
3. a determinant of roles, human relationships, social functioning, group behaviour, social co-ordination, human development and personality;

4. the subject or determinant of human signalling, stimulus-response sequences and communication.

These approaches to the law will not be explored in this thesis, although such studies might add to the development of jurisprudential systems science and the science of legal choice. The law may be seen as a thread running through the Darwinian paradigm of human psychology. The purpose of this thesis is to develop the structure of this thread. In doing so, the law is first regarded as setting a scope for human behaviour, in particular, goal-directed behaviour. Within this scope, there is room for human diversity or choice. Patterns of choice may be schematized to suit human cognition. The law sets the choices of goals and the choices of means to these goals. Within this scope of potential behaviour, the system of legal choice ensures co-ordination of actual diversity in the satisfaction of individual needs and wants. However, the thread of law is itself confined by natural selection and the scope for human self-determination and informed conscious selection.

Peter Brett, in his book, *A Contemporary Jurisprudence*, published in 1975,(5) suggested that gestalt theory in psychology, might be the signpost for a more advanced jurisprudence. The Gestalt School originated in Germany, early in the twentieth century, with the works of Wolfgang Kohler, Kurt Koffka, and Max Wertheimer, all of whom migrated to the United States of America before the second World War. Gestalt psychology was concerned with natural wholes, and maintained that the whole was more than the sum of its parts. It was concerned with examining not just the parts but the interaction of parts, in order to determine the nature of the whole.

Independently of Brett's work, Thomas Glyn Watkin, in his book, *The Nature of Law*, published in 1980,(6) examined the phenomenon of law by reference to some of its various jurisprudential dimensions, and found that it was descriptive of social reality as it is experienced by people. Watkin begins by establishing that law exists as mental phenomena which amounts to a social phantasy system. On this basis, he points out, the subject matter of legal reasoning is therefore phantasy, and the reasoning process might

be like the reasoning of phantasy, rather than the reasoning of science. He then considers the nature of legal rules, legal validity, legal concepts and legal systems, as phantasies, and applies his findings to the problems of the relationship between law and morals, and the justification for intolerance of civil disobedience. In his study of rules, he finds that the phantasies are messages to be found in the patent and latent meaning of the rules. To see the messages, the fragments of rules have to be examined as a whole. Like phantasies, rules have structure with meaning. Just as phantasies serve a purpose in human life, so too do rules of law. In law, disputes between individuals are raised and settled symbolically. Rules are given collective ratification by society like the rules of a game. Legal validity is recognised because it produces social cohesion and human survival. Legal concepts, such as rights, duties, powers, privileges, liabilities, immunities and no rights, disabilities, claims, and legal actions, assist the individuals in society to work the rules in relation to their social interactions. Legal rules, validity and concepts make up the legal system. Rules of law and the decision to obey them should turn upon a social survival evaluation of their messages.

Watkin suggested that people should be regarded as the starting point of a legal system. Social organization is necessary if human beings are to have any assurance of survival. Law promotes survival through society. Watkin examines the relationship between law and survival principles.

The emergence of law, therefore, marks the incorporation of survival principles into legal rules by a process akin to hardening because those precepts which cannot be broken without risking disputes have to be spelt out by the group to its members. Legal rules are, therefore, a sub-category of survival precepts and are related to, and will be seen to resemble, the other survival precepts, breach of which does not risk disruption.(7)...

Legal systems emerge as a result of this institutionalizing of dispute situations and their solution in a manner which attempts to preserve the peace of the community.(8)...

Thus, it can be seen that it is generally the case that the best-suited principle of a

community emerges at times when the cohesion and possibly even the survival of the group is in jeopardy.(9)...

There is always, of course, the danger of the best-suited principle failing to provide the correct enunciations for cohesion and survival. The best-suited principle has to be constantly ratified through continued acceptance of its enunciations.(10)...

When a best-suited principle ceases to provide the enunciations which can be accepted as correct for cohesion and survival, changes do occur.(11)...

Whether the community's choices are in fact the best for cohesion and survival is always an empirical question which has to be answered in relation to each community at any given moment of time.(12)

Frank K.H. Maher, who was a colleague of Peter Brett at Melbourne University Law Faculty in Australia, conceived the law as a 'golden braid', in an unpublished paper (13) in which he applied to the law the ideas expressed in Douglas R. Hofstadter's book, *Godel, Escher, Bach: An Eternal Golden Braid*.(14) Although Maher was interested in the automation of law, he did not identify the behavioural context in which artificial intelligence might be useful. Therefore he did not explore the patterns of behavioural choice in law. Hofstadter was concerned with the paradigms which are used to create working models of the world. If the models cease to solve problems,, then they might be modified or replaced. Maher saw that the identification of the legal model was necessary in order for it to be fully effective and automated. He set about to use the paradigms of computer technology to establish an approach to finding the structure of the model in traditional legal theory.

This thesis is concerned to discover in legal information, metaphysical structures and processes which can be used to enhance the effectiveness of legal information, and assist in the design of artificial legal intelligence programs. In the course of building computer programs, information systems may be improved, producing a more intelligent system. Law has arisen to resolve conflicts between individuals about goals and the means of goal attainment. Rules that prescribe priorities in the event of conflict may expand the opportunities for goal-attainment, as long

as the legal choices are understood. If information is available about legal choice, in a form suited to human cognition, then the law may optimize human co-adaptation. If legal choice is not understood, so that opportunities are not taken, then unnecessary conflicts and dissatisfaction may occur. Some law is more complex and difficult to understand than other law. This assumes different levels of intelligence. People who understand how to 'work' the law, may enjoy greater advantages than those with more limited knowledge and understanding. Furthermore, a law of mixed intelligence may produce diverse sets of ethics which can not be co-ordinated. The science of legal choice is concerned with the formulation of behavioural choice which is implicit in the rules of law so that it may be readily understood and examined by people with various levels of comprehension, to see if it could be used or modified to enhance life.

As a science, psychology is not concerned with establishing ideal ethics for human life. However, it does explore actual behaviour in various circumstances and how effectual alternative behaviour might be in regard to the quality of life of its subjects. For instance, the tests which were carried out by H.C. Blodgett at the University of California in 1929, to study the phenomena of learning, also study the techniques of rats for satisfying the need for food. The experiment was designed on the basis of choice and purpose. Rats in group one were put into a maze without food and left to explore the choices of pathways. A second group of rats were put into the same maze with food in it and learned over a period of time the routes which led to the food. The first group were then put into the same maze with food in it. Their previous experience with the maze enabled them to learn the routes to the food in a shorter time than the second group had taken. Their 'learning for learning's sake', had paid off when food did become available. Psychology deals with natural goals and the effectiveness of means for goal attainment. Much of human life is like this. It is not concerned with whether the ends are justified and justify the means; such matters are not in issue. The law could be learned like a maze if it was presented as a jurisprudential maze.

One of the purposes of the American Psychological Association, which was founded in 1892, is stated as the promotion of human welfare. Some psychologists recommend the use of psychological theory to assist human survival. For instance, Frank J. Bruno in his introductory American text, Behavior and Life, states in his Prologue that, although the text is not a book on how to survive, nevertheless the information which it contains may contribute to the capacity of the individual to meet the 'challenges of life'.

In particular, much of the work in fields of interest such as counseling and clinical psychology, learning, developmental psychology, and feedback is aimed at helping people improve the condition of their lives. Psychology certainly has something to do with coping effectively with the challenges of life, and it is appropriate that we explore what some of these challenges are. (15)

The science of psychology has not examined directly the challenges of life that are presented by law and legal games. It does not study law as a cognitive system, or as a system of behavioural choices which constitute opportunities for the satisfaction of individual needs and wants, or as a system which co-ordinates the preferences of individuals to optimize freedom to be diverse about the level and kind of personal satisfaction required. The discipline of psychology makes no attempt to assess whether or not the law is suited to human psychology, including social psychology. Such studies are the domain of jurisprudence, but they could belong in an interdisciplinary domain. Law could be evaluated within the framework of the Darwinian paradigm of the human psychology of the client. This thesis is concerned with such an evaluation. The volume and complexity of law contains a maze of choices, involving the possible worlds of Nature. This maze has been designed in fragments with no master plan for the user. Neither psychology, nor jurisprudence has produced a blueprint of the maze so that people can learn in advance of its challenges and opportunities. Such a blueprint is required to promote human welfare. However, the volume of law goes beyond the capacity for memory of the ordinary individual, including the ordinary judge, and its complexity goes beyond the capacity for mental processing of ordinary people. Artificial intelligence aids are required.

As legal theory has expanded and increased in complexity, it has become more and more remote from coherent meaning for individuals in the context of their daily lives. The legal choices which bear on the satisfaction of needs and wants and individual goal attainment, are not presented clearly in the rules of law and legalist theory. The rules are not interpreted holistically as a system of behavioural choices in a conceptual structure which can be processed cognitively by the individual. Without this form of communication, the law can not be effective as a signal which instigates a stimulus-response sequence so as to fashion roles, social functioning, and eventually achieve the satisfaction of needs, wants and individual goal attainment, that will result in a society of individual personalities who can develop intelligent human life. It may be human instinct to have law, and human intuition to relate to law, but law is a conscious rational technique for human survival. It is a product of human intelligence, to sustain human intelligence; this phenomenon is sometimes regarded as civilization. With heightened intelligence about the law, civilization might improve. The twentieth century has been the bloodiest century in human history. Civilization needs a new bastion of social co-ordination. The law can be interpreted and analysed as a jurisprudential system of behavioural choices. Clear specification of legal choice may be produced for informed decision-making which will motivate human co-operation and achieve the co-ordination which is necessary for peaceful human survival and social co-adaptation.

The disciplines of sociology and welfare studies, which are closely related to psychology incorporate some study of the law but neither of these disciplines have developed a science of legal choice. Again, a knowledge of the rules of law and their practical implications, is required in order to discover the maze of behavioural choices implied by the system of rules. A science of legal choice can only be developed within the field of law as a form of legal science or jurisprudence. In welfare studies, there has emerged an ethic of social welfare, based upon the Darwinian paradigm of human psychology. Social welfare policies have influenced the development and application of law. A science of legal choice may assist welfare studies and practice, and promote welfare equity in the legal system. Such a science might also

open new fields for testing and survey in psychology and sociology.

Jurisprudential Systems

A jurisprudential system is defined as a conceptual or verbal system which can be identified in or drawn from legal information. Jurisprudential systems which deal with macro-structures of legal information may be termed general jurisprudential systems; those which deal with the minutiae of legal concepts and rules, the micro-structures of legal information, may be termed specific jurisprudential systems. The arrangement of legal information for a legal expert system constitutes a specific jurisprudential system. These systems may be purely cognitive, or they may contain some ethical or evaluative aspects. This Chapter is concerned with a general jurisprudential system, namely SURMET, which provides a general cognitive framework for the ethical evaluation of specific cognitive systems. This amounts to a nesting of cognitive and ethical systems. SURMET itself could be nested in a larger evaluative system, such as the jurisprudential system of this thesis, so that it could be established or evaluated as a general jurisprudential system. In Chapter Seven the concept of specific jurisprudential systems, and the use of such systems in the design of computer programs, is explored.

Systems science is the study of systems in the various sciences with a view to finding principles or developing theory which applies to all or some classes of systems. The principles of wholeness of a set of inter-related or inter-acting elements is the concern of general systems theory. It has been recognised in systems theory that there may be verbal or conceptual systems which share with other sorts of systems, the same systemic characteristics. The founder of General Systems Theory, Ludwig Von Bertalanffy, asserts this quite clearly.

System theorists agree that the concept of 'system' is not limited to material entities but can be applied to any 'whole' consisting of interacting 'components'.(16)

Common systemic characteristics are as follows:

1. A boundary
2. Elements
3. Arrangement(s) of Elements
4. Open or closed
5. Flow(s)
6. Homeostatic control(s) - maintain the status quo
7. Heterostatic control(s) - make evolutionary changes
8. Purpose(s)
9. Environment
10. Sub-system(s)

Perhaps not all systems have all of these characteristics; however, all of these characteristics may be identified in legal information. This is demonstrated through the system, SURMET. A general jurisprudential system such as SURMET, throws new light on the suggestion of Hans Kelsen that the legal system is a hierarchy of norms founded upon a single Grundnorm.(17) As well as having some deontic substance, a grundnorm must also have a form. If it has the form of a system, rather than a single principle, then its content may be a number of ideas, associated for a purpose. The form of the grundnorm may lead to a system of practical reasoning, which incorporates a number of Aristotelian sets, rather than a single, holistic, Aristotelian hierarchy of rules.

There are ten aspects of the entity of a system which may each contribute to the existence, nature, and stability of the system. The idea of a system may be regarded as a formal grundnorm, a paradigm of human intelligence, which provides a framework for the substantive content of legal information. When the substantive content of legal information is used to fashion a general jurisprudential system, the substantive grundnorm, namely, legal information, must be viewed from each of the ten formal perspectives.

Kelsen used the Aristotelian paradigm of a metaphysical pyramid, as a framework for his hierarchy of norms. His substantive grundnorm is the principle at the top of the pyramid. Norms at higher levels determine the validity of laws at lower levels. The pyramid is a static structure which is not suited to representing

the decision-making processes of legal choice. Furthermore, Kelsen admitted to the pyramid only the law, as it is determined scientifically. His was a pure theory of law which merged positive and analytical jurisprudence with the 'spirit of the law'.

This Chapter seeks to develop, on the basis of the client paradigm, a system of survival information, SURMET, which anyone could use as a survival aid. The system contains the resources of human intelligence, arranged to facilitate survival decision-making. Human needs and wants are codified in the system and its goal is the satisfaction of specific needs and wants. Incorporated in the system is a memory of knowledge and experience, arranged to facilitate the processing of a survival or satisfaction problem, particularly one which involves the law. Information about the problem is processed to resolve expectations, and, if appropriate, directions to behave in a certain way to achieve a specific goal.

SURMET

A composition of macro-structures in legal information, which contains all the features of a system, and which constitutes the general jurisprudential system, SURMET, is set out in Figure 1. The scheme is set out in two dimensional boxes. However, if the content of the boxes were to be particularised and put into operation, then the system would take on a three-dimensional form in metaphysical space. Some indication of the nature of this three-dimensionality is captured in the paradigm of the world of rivers which is posed in Chapter Seven. Broadly, SURMET may be understood, objectively, as a legal information system, and, subjectively, as a metasystem of a collective human consciousness, which might be adopted, by anybody, as a personal thinking system. In any case it is a metaphysical entity and its environment is metaphysical. Also, its elements, which are mental concepts, and their processing, are metaphysical. The boundary of SURMET is the overall description or delineation of it as a general jurisprudential system: its broad nature and limits. It is an open system which receives new information from its environment, particularly information which can be formulated as legal

A GENERAL JURISPRUDENTIAL SYSTEM

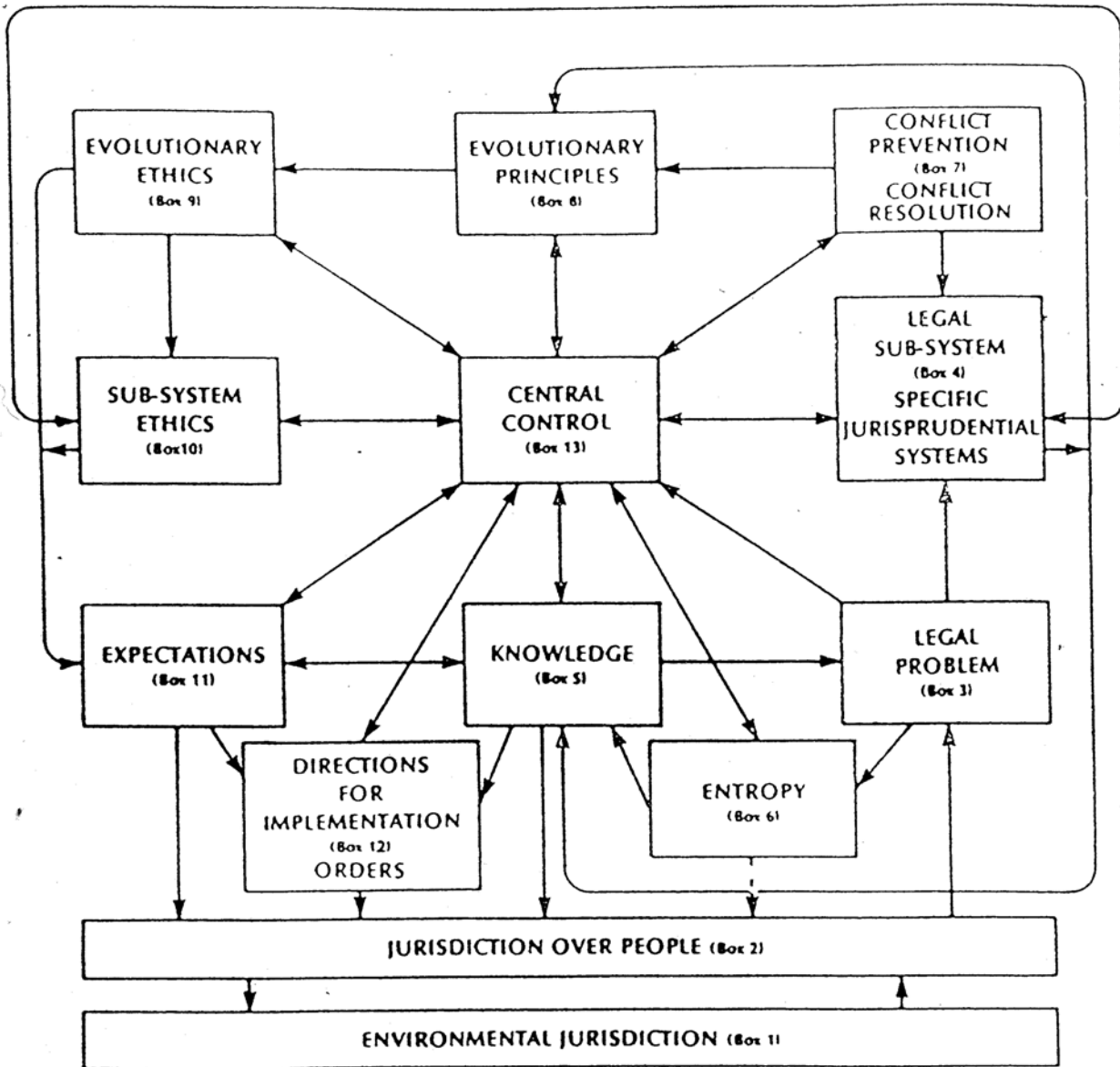


Figure 1 SURMET (SURvival METAsystem)

problems. Its output is in the form of directions in response to the input.

SURMET may be examined by reference to the macro-structures of legal information which constitute its boxes and flows. The boxes are determined as answers to questions about legal information: the what, who, where, when, why and how (5W & H) of legal information. Legal information is considered from these perspectives to establish both matters of legal theory and matters of legal choice. From each perspective, different elements, structures and processes of the system can be seen. SURMET has both 'is' elements, and 'ought' or command elements. Different perspectives are concerned differently with each.

The boxes are a storage system, and the flows between boxes allow for an orderly traffic of information. These boxes and flows are a systemic framework which gives structure to the system; they have a homeostatic function, which stabilizes the elements of the system which they contain, especially while the system is in operation. SURMET contains both the static and dynamic structures of legal information.

Primarily, SURMET uses a paradigm of the cosmos, or the atom: they have a similar form. It is, metaphorically, a system of interconnected galaxies that are to be found in legal information, in its broadest sense. SURMET is concerned with the organisation of all information which a legal expert might use. The relative aspects of legal choice are accommodated in the system, as well as the schema of alternative pathways of possible legal scenarios. The system is orchestrated by the processes of human intelligence. Its workings are like journeys through the cosmos, carrying supplies and performing other processes, here and there, in an orderly fashion.

Prima facie, the form of SURMET is suited to the design of computer programs which can perform certain tasks that require human intelligence: SURMET represents collected data, or the memory of information, as well as the storage, retrieval and processing of the data. However, to use SURMET as a design aid requires appropriate specification of its content, and the

determination of programmable data structures. Furthermore, its operations must be specified as processing algorithms and control strategies. In this Chapter, SURMET is only considered as a systemic framework for legal decision-making. A broad description of its boxes is as follows:

a. Environmental Jurisdiction - where (Box 1)

The law claims a jurisdiction over the environment, be it moveable or immoveable. Accordingly, legal information accommodates environmental structures; this is done largely through property law. On a scientific view, the environment may be seen to have macrostructures that are identified by relativity, ecology and evolution. Some recognition of these macrostructures is reflected in modern environmental law which seeks to protect the ecology. This is seen to be of benefit both to the environment and to people. The environmental jurisdiction may be distinguished as a macrostructure in legal information, incorporating all the elements, structures and processes that are recognised in property and environmental law.

b. Jurisdiction over People - who (Box 2)

The law also claims a jurisdiction over people, who live in certain relationships to each other and in relation to particular environments from time to time. In science, human beings are regarded as animals and part of the world of physical relativity, ecology, and evolution; human behaviour is studied as a matter of individual and social relativity, ecology and evolution. Legal information accommodates the relationships and transactions of people in their various environmental circumstances from time to time. The notion of legal status provides some of the elements and structures by which people are recognised in law. The changing legal positions of people which are recognised in the law, may be described as legal relativity: a change in the actual legal position of one person, may have consequences for others. The rules of law which orchestrate legal relativity as people go about their activities, may be regarded as the rules of the games in law. These games could be portrayed by specific jurisprudential systems which are designed according to game

science paradigms. Legal relativity is a form of human relativity; it effects a form of human ecology. Insofar as the law is an evolving body of legal information, it contributes to cultural evolution. Jurisdiction over people may be distinguished as a macrostructure in legal information, containing all the elements, structures and processes, concerning people, which are recognised in law.

c. Legal Problems - what (Box 3)

Legal problems arise from the jurisdiction of the law. People are usually engaged in activities which are in pursuit of the satisfaction of their needs and wants: these activities may be described as survival pursuits characterized by goal directions. Generally, the law does not require people to adopt goals and engage in survival pursuits; it is in the nature or habit of people to do these things of their own volition. The law arises to settle conflicts which occur in these activities. The goals which people nominate for themselves and the activities in which they engage in pursuit of these goals, sometimes entail conflict between people because of the nature of the physical world. Two people can not occupy the same place or deal with the same thing in the same way at the same time; one person can not be in two places at once. There are many physically necessary constraints on the activities of people in relation to each other and to their environmental circumstances. Some of these matters are recognised in law through the use of the rules of logical necessity, although logical necessity may not always coincide with physical necessity. Conflicts may give rise to competitive behaviour, some of which may be anti-pathetic to human survival, and some of which may improve human survival. This predicament produces a multitude of legal problems, the elements, structures and processes of which constitute a macrostructure of legal information.

Legal problems may also occur because people wish to plan their activities so as to avoid conflict with others; further, if people do fall into conflict, they may wish to find out how to resolve this conflict as well as they can. The law provides for the resolution and prevention of conflict; but to deal with the position of any individual, the relevant aspects of law must be

applied to the position and circumstances of the individuals concerned. These legal problems contain various perspectives of the law, each of which may require a specific jurisprudential system or a dimension of a specific jurisprudential system to produce the solutions sought. Legal problems may be distinguished as a category of macrostructures of legal information. Their solution will amount to a determination of legal relativity. Legal expert systems may be constructed to deal with legal problems and provide their solution.

d. Legal System - Sub-systems - what (Box 4)

The entities referred to in Boxes 1-3 may be extracted from legal information so that their elements, structures and processes may be examined separately, and may be used as perspectives from which to view any other part of the system. These entities are not recognised in this way in the legal positivists' view of law. The legal system which is fashioned by the legal positivist school, that is, the concepts and rules of law determined by authorised law-makers, or the primary source law, is included in SURMET as a sub-system of the general jurisprudential system. There are advantages in maintaining the positivist legal system in this way; the legal system has homeostatic and heterostatic controls which may be termed juridical pragmatics, which are best studied in the positivist context. As a sub-system, the legal system, with its juridical pragmatics, operates as a macro-structure of legal information. Specific jurisprudential systems may be formulated within the legal system, according to its juridical pragmatics.

There are elements of science in juridical pragmatics. Law is stated on the basis of facts which are established scientifically. These facts usually illustrate a social situation in which at least two people have fallen or might fall into conflict. The law of evidence ensures that facts are proven by observation and, where appropriate, by expert witnesses who are acquainted with what has elsewhere been established scientifically. Some social disorder is thereby established. The outcome of these facts is constituted in the court orders with which the litigants may comply or which may be enforced through authorised law enforcement agencies. The court's decision and any enforcement measures are

duly recorded in a scientifically proper and systematic fashion. Records are kept of the case in an established and reliable system of categorization. The administration of the legal system is scientific.

The facts of a case, including any order handed down, represent the law. However, this is not the law which is followed in subsequent cases, for good reason: no subsequent case would ever be identical. It is the ratio decidendi which is binding. The reason for the decision is a description of the scope for drawing analogies between the facts of the precedent case and the facts of future cases. By a process of induction and abstraction, principles of law are derived from particular cases. The conflict or disorder, which is described in the facts of a case, is inherent in these principles and rules which are formulated as the binding ratios of specific cases. These ratios determine priorities and order in human activities. They are applied to new cases by a process of deduction. If the new case falls within the paradigm of a ratio, then the ratio applies. The new case is treated in the same way as the precedent case: there is a form of analogy recognised. Sometimes a new case does not fit an existing paradigm to its full extent. Several ratios apply, each to a limited extent. A new paradigm must be made up by fitting together the relevant parts of the several partially applicable ratios. To find the scope for analogies between precedent and new cases, it is sometimes necessary to discount those differences which detract from the complete analogy.

The scope for analogies, or deduction, is seen more clearly if ratios are expressed in a standard or normalized format, such as the format, 'if...then'. A simple example might be: 'if there is a contract, then it may be enforced'. The command format is appropriate when the law is viewed as directions to behave in a certain way, e.g. 'don't steal'. Positivist law may be treated as a description of people, their activities, and their environmental circumstances in which patterns of legal relativity are identifiable as systemic structures. Legal relativity in the sub-system is limited by the positivist domains, whereas legal relativity in the jurisdictional domain may be extended by the actual position of people in relation to the actual environmental

circumstances from time to time. Within the legal problems box, legal relativity may be modified to deal with patterns which the law does not cover.

Only ratios which are consistent with other ratios and with legislation, that is, only priorities and order which are consistent with other priorities and order, will be employed by the judiciary. In this way, the collection of ratios and legislation which constitute the body of law from time to time, take the form of a coherent theory. This theory is the information which remains constant no matter from which perspective it is viewed. It is constructed from cases, and fixes each case in relation to each other case, and to future analogous cases. Positivist legal theory is a sub-systemic structure of legal information.

The legal positivists have created Linnaean forms of systematization of legal information, consistent with its theoretical structure, in order to assist in the cognitive management of the law. Substantive law is categorized like the genera and species of living things, and the parts of a living being. A Linnaean structure lends itself to formulation as nodes and branches of a tree which may provide a basis for decision trees. These structures may be regarded as sub-systemic structures of the general jurisprudential system; they may constitute specific jurisprudential systems and a basis for development of further specific jurisprudential systems.

Legal theory, like scientific theory, incorporates past and hypothetical cases. Judicial strategy which keeps theory constant, permits the evaluation of existing or hypothetical problems in order to determine their outcome, and thus, the planning of future activities. Like scientific theory, legal theory is designed to permit predictions. The law provides some certainty about the future and the opportunity for the peaceful pursuit of subjectively determined personal goals.

The determination of law is not without experimentation, although there has been a long standing reluctance of the judiciary to admit to this. Precedents may be over-ruled, and legislation may

be amended or repealed. Therefore, when the law is laid down, it is experimental. The reluctance to admit the experimentation in law has probably been for various reasons. Primarily, the authority of the law would be diminished if there were an acknowledgement that it might be wrong. Experimentation also presupposes that the judiciary make or invent law, and this for a long time has been denied. Judges have claimed to find the law through reason. The objectivity of reason is both the method and justification of the law. The judiciary is then relieved of personal responsibility for the law, and they do not have to justify a subjective method. In recent times, with the impact of empirical studies of judicial decisions by the American Realist School of Jurisprudence, there has been some acknowledgement by judges of the law-making practice of the judiciary, but in circumstances where it is apparent that a very small proportion of the law might be experimental at any time, and that the larger part of it constitutes unchallengeable authority. The rate of change in the law is limited to a small proportion of law and therefore it is likely to amount overall to a slow rate of change. This indicates, in the sub-systemic controls of juridical pragmatics, homeostatic activities which preserve the status quo and heterostatic activities which make gradual modifications. The balancing of these activities produces an overall stability of the sub-system.

The validity of judicial experimentation might be monitored by a collateral sub-system. In the determination of law, or the generalization to hypothetical future cases, reliance is placed upon a population sample which is not representative. One case situation may predetermine a great many future situations. There is no empirical investigation of all the social circumstances that might be relevant to future cases which fall within the ratio. Decisions are handed down on the basis of an adversary procedure which precludes all but the litigants from the right to be heard in the matter. Nevertheless, the decision may affect the remainder of the population in ways which the court has not considered. The judge's personal knowledge of the interests of non-litigants, if any, collected informally, might be taken into account. However, there is no certainty that the judge has either the relevant knowledge of other's interests or that such matters

have been taken into account in the decision-making process. The scope of the enquiry is limited to the realms of established legal theory and the realms of relevant, admissible evidence. The confines of relevance and admissibility by which the facts of a case are established, are treated as the extent of the empirical enquiry in the case, even though other facts may fall within the ratio. Litigation is thereby made expedient in the short term.

In a collateral sub-system, the facts of a case may be treated as a sample of the totality of relevant facts, and the parties may be treated as a sample of the population which might be in similar circumstances. Investigations may be carried out to canvas a broader scientific basis for determining law. It is not open to the court, given its procedure, to scientifically control the population and secure a representative sample. The extent of the investigations is limited to the rhetorical spectrum portrayed by counsel. Sampling errors may only be rectified through the feedback of future cases when precedents may be over-ruled or modified. The law may be regarded as an ongoing experiment through which sampling errors are being rectified. Sampling errors may produce an incorrect projection of the future course of events or they may produce distortions in theory. Even if there were no sampling errors, theoretical errors may occur due to a failure to manage a vast and complex system of thought which, by nature, will continue to increase and grow in complexity. A collateral sub-system may enhance the legal system.

Other sub-systems of human life, such as communication systems, learning systems, personality systems, social systems, political systems, economic systems, systems of human interaction with the environment and systems of human ecology, may be accommodated in Box 4 as collateral sub-systems. These collective and personal systems are subject to the control of the legal system, and the legal system may take its structure from these other sub-systems. A certain range of sub-systems is required to achieve the purpose of the general jurisprudential system. For instance, the legal system must be supplemented with an economic system which can organise the production and distribution of resources for the satisfaction of personal needs and wants. Specific jurisprudential systems, such as legal choice systems, may also be

located in Box 4 as collateral sub-systems. The sub-systems must be maintained consistently with each other and so as to attain the purpose of the general jurisprudential system.

e. Knowledge - what (Box 5)

Human knowledge is used in legal information and may be distinguished as a macrostructure of legal information. Knowledge may be common knowledge, which is derived from common experience, or scientific knowledge. Expert evidence is referred to in the legal system if required. Included in knowledge are some major structural controls of legal information: these may be recognised as the rules of language, logic and mathematics. Both common knowledge and scientific knowledge may be determined and stored as a resource of the general jurisprudential system. If computer aids are to be enlisted in the administration of the legal system, then a knowledge of computer technology will be available in the system for the appropriate treatment of positivist law in relation to legal problems.

f. Entropy - what (Box 6)

Information which enters the system and can not be located elsewhere as part of the order of the system, may be located in the Entropy Box. Through the Entropy Box, disorder may be confined, and a resource may be kept in case this information should in the future become useful. Entropy may contain information about what is not knowledge and what is not law. If the information system was used as a thinking system, then it would be bound by a characteristic of human memory, namely that once information is experienced, it can not consciously be discarded from memory. Provision must be made for its storage or it may create disorder in the system; in any event, the information, even if it is entropic, may still be a resource. Confining information in this way, confines the non-structure of legal information and thereby, indirectly, determines the nature of legal information.

g. Conflict Resolution and Prevention - why (Box 7)

The overall purpose of legal information may be regarded as the resolution and prevention of human conflict. Order should then follow. This overall purpose influences the structure and processing of legal information. A specific jurisprudential system may be designed in accordance with both the specific purposes or goals which are derived from jurisdictional instructions, and the overall purpose of the general jurisprudential system. If specific jurisprudential systems do not comply with the overall purpose, then the general jurisprudential system may be at risk.

h. Evolutionary Principles - how (Box 8)

The purpose of legal information, namely, the resolution and prevention of human conflict, presupposes that there are people. The system can only be maintained by people, since it is a matter of human collective consciousness. Legal information has been created by the activity of a collective consciousness and it is maintained by the activity of a collective consciousness. It is therefore in the interests of the system to ensure that people survive and that its purpose is achieved in a way which is consistent with human survival. Knowledge of the principles by which people can survive may be stored separately as evolutionary principles. These principles are Darwinian, or modifications of the principles originally proposed by Charles Darwin in his book, The Origin of Species, published in 1859. (18) Since everything survives according to these principles, the general jurisprudential system itself will be subject to these principles. Legal information is a changing or evolving body of information. Evolutionary principles may be seen to govern these changes.

The law is a method by which people survive and people have survived through the law. Therefore, however unwittingly, decisions made in respect of, and in accordance with, the law, must have complied with those principles of nature by which a species maintains an evolutionary niche. Generally people conform to conflict avoidance measures of the law because peaceful pursuits produce conditions of life more favourable to survival

than the law of the jungle which might prevail if there were no conscious controls of human society. If the law is examined with a view to identifying in it the Darwinian principles, then it may be seen that the minutiae of law is an operational form of static evolutionary principles. Perhaps Darwin's original principles of survival were a reflection of his political predisposition rather than a science of survival. Nevertheless, law may be regarded as a science of human survival. It might be possible to consciously develop legal information on the basis of scientific knowledge about how to produce the best conditions of life and secure the evolutionary niche of people. Optimum survival for everybody may be the equitable grundnorm of conscious selection of evolution.

Major evolutionary principles of survival may be seen as follows:

1. Optimum conditions for survival (quality of life) maximize chances of survival.
2. Diversity (maximum choice) maximizes chances of survival.
3. Maximum population maximizes chances of survival.
4. An identifiable survivor occupies an evolutionary niche which is located in an environment of other evolutionary niches occupied by other survivors. As survivors pursue principles 1, 2, and 3, they necessarily encroach on the niche of others. Niches must be maintained relatively.
5. Survivors may change according to genetic predetermination, mutation, chance, and teleological or purposeful ordering.
6. A survivor and the survivor's niche must fit each other and continue to fit each other.
7. To maintain or extend a niche, the survivor in occupation must have changes which resist the encroachment of others, or, which encroach on

the niches of others.

8. Co-operation and co-ordination (co-adaptation) of survivors maximize chances of survival.
9. Evolution occurs by the interaction of microforms and macroforms of energy. Natural selection is the order in this interaction: it may be relatively necessary or random.
10. Human consciousness has a capacity to control natural selection.

The use of law as a survival method gives effect to principle 8. The minutiae of law may be understood as a pursuit of principles 1, 2, 3, 6, 7, 8, and 10 through an understanding of the operations of principles 4, 5, and 9. Where the pursuit of one principle conflicts with the pursuit of another principle, the pursuits must be balanced; each pursuit must be limited to optimize survival. Some legal reasoning demonstrates a mastery of this form of decision-making. In the framework of SURMET, natural selection and conscious selection must be balanced to maintain the equitable grundnorm, which in turn will realise the overall goal of conflict resolution and prevention.

When the needs and wants of people are examined, it is clear that a person's needs and wants are founded in evolutionary principles. Some needs and wants may be seen to be personal; others may be seen to be social. The following is an outline of human needs and wants:(19)

1. Personal needs :

space
sustenance
shelter
exercise
protection from: inadequacies of self
 offensiveness of others
 non-human environment
 natural elements
 disease,
 animals

2. Social needs - personal wants :

sex - reproduction
education
exploration
communication
exchange
co-ordination
meeting

3. Social wants - personal wants :

evolutionary ideals
procedure to reach these ideals
religion, ideology or philosophy
mutual understanding - trust or agreement
mutually satisfactory priorities

4. Personal wants :

self-realisation, personal development, personal
certainty and security
quality of life: place)
peace)
comfort) for pleasure
consortium)
choice)
mobility)

minimum compromise of self)
maximum compromise of others) selfishness

Personal goals may be adopted from the range of personal and social needs and wants. The goals will be the satisfaction of specific personal needs and wants from time to time. The range of human needs and wants indicates the scope for determining personal goals. Potential personal goals may be an indication of the survival activities with which the law will be required to deal. Actual goals will arise in the jurisdictional domains and form part of a legal problem. The significance of goals in dispute may be examined in terms of the evolutionary principles which underlie them. Solutions may be found by reference to the equitable grundnorm: optimum satisfaction of personal needs and wants for all parties concerned in the conflict.

Personal and social systems (Box 4) may be seen to have evolved with the aid of the law to provide for the satisfaction of these various needs and wants. The law may take account of these personal and social systems in order to assist in their development. For instance, a system of territoriality is effected by property law; a system of marriage is administered by the law. Contract law provides optimum diversity in exchange activities; the law of tort and crime provide protection from the offensiveness of others. The basic assumption of law is that people are free to do whatever they choose unless the law provides otherwise. People are not required to pursue the satisfaction of their needs and wants but if they do, then the law determines the

priority of activities by way of co-ordination which minimizes obstructions and conflicts.

All people are equal before the law. However, this does not mean that the law will provide the satisfaction of needs and wants to the same extent for each person. Rather, it means that all persons who fall within the descriptions and prescriptions of the law are treated according to that description and prescription: the activities of all people are subject to co-ordination by the law. As the population increases and human activities become more and more diverse, the task of co-ordination becomes more complex. Uniform rules may no longer be appropriate and it might be expected that more precise regulation and communication will be required.

i. Evolutionary Ethics - how (Box 9)

A command structure of legal information, namely 'ought', may be used to transform evolutionary principles into evolutionary ethics. William C. Charron claims that this sort of information has the logical structure of assertoric hypotheticals: if you want a then you must do x.(20) In this there is both an ethical ontology and an ethical methodology. Knowledge-based ethics are rational if they are contained in a goal-directed system. In practical reasoning, 'ought' may follow from 'is': people ought to do that which they know will achieve their personal goals. When the conversion from principles to ethics is made, the ethics may be seen to have a basis of human needs and wants. People may be motivated by their needs and wants. The personal command structure of legal information may be closely related to human motivation. From this ethical view, it is easier to recognize that the law is a particularisation and balancing of evolutionary principles.

Evolutionary principles may be remodelled as the following evolutionary ethics:

1. People ought to do that which will produce optimum conditions for human life.
2. People ought to do that which gives them maximum choice.
3. People ought to reproduce.
4. People ought to co-operate with each other.
5. The co-operation of people ought to be co-ordinated.
6. People ought to keep within their limitations.
7. People ought to adapt to changes.
8. People ought to change to adapt.
9. People ought to do that which is fitting and suitable.
10. People ought to consciously control the interaction of microforms and macroforms of energy.

It is possible to formulate various evolutionary ethics. Those which are formulated may at times provide conflicting directions, so that a selection of priorities will be required, to suit the problem that is being processed. Just as evolutionary principles underlie the law, so too evolutionary ethics, founded on these principles, form the basis of legal system ethics.

j. Legal System Ethics - how (Box 10)

The rules of law may be set out in accordance with a personal command structure of law. For instance, on the basis of the law of negligence, there might be an ethic which states that people ought to exercise a certain standard of care in their activities to avoid harming others. This will have the effect of maximizing the population, providing favourable conditions for human life and protecting people from harm. These ethics may provide a clear indication of the requirements of law.

k. Expectations - how (Box 11)

Where the legal system permits predictions and is maintained as a stable body of information, giving rise to reliable predictions, people may have expectations about the future and act with some certainty that these expectations will be realised. People may plan on the basis of expectations which may be formulated from legal information and its ethical implications. By providing the opportunity for planning, the legal system allows for strategies for conflict resolution and prevention.

l. Directions - how (Box 12)

On the basis of what is expected in law, directions may be formulated for some person or persons to do or not do something. These directions may take the form of court orders or the enforcement of court orders or they may be in the form of legal advice. They may be regarded as authoritative command structures in legal information. Once formulated, directions are passed on to people as verbal or conceptual instructions which may then be acted upon in the physical world. These directions constitute the output of the system.

m. Central Control - when (Box 13)

The central control performs several homeostatic and heterostatic functions in the system as follows:

1. The determination of system elements.
2. The arrangement of system elements.
3. The determination of flows between elements.
4. The determination of the flow of input and output.
5. The determination of changes in elements, in their arrangement and in flow courses.
6. The determination and balancing of homeostatic arrangements of elements, to maintain system stability

and to achieve system purpose: maintaining the status quo.

7. The determination and implementation of heterostatic arrangements of elements, to maintain the stability and effectiveness of the system in a changing environment: the introduction of improvements and necessary modifications, as a matter of change, development and evolution.

The activity of the general jurisprudential system is orchestrated by the central control. It is like the central processing unit of a computer which uses programs to simulate human intelligence through processing information. Paradigms of human intelligence are used by the central control, just as the central processing unit uses programs. Box 13 may be understood as the methodology of the system, the core of human intelligence. Its activities may take the form of scientific methodology. It is part of the ontology of the system that it has a methodology; and the methodology is a determining factor of the ontology.

n. The Flows

SURMET is an open system with flows which are designed to process input in the form of legal problems received from people that may or may not involve environmental considerations. It contains resources for dealing with human conflict, and provides a basic organisation of information so that solutions to human conflict may be found. Past experience is incorporated in the information of the system. Input may be processed according to the flows within and between the boxes. Output may be produced in response to input.

In a sense, SURMET has the resources of the metaphysical domain of mind. Elements of the system may be regarded as verbal or conceptual quanta. These information quanta may be duplicated for the purpose of representing time sequences or other patterns: alternative patterns may be useful in a problem-solving process to test alternative hypothetical solutions. The central control formulates these elements from input data, and locates them in the boxes so that the stability of the system is maintained and its purpose is achieved. The location of elements in the boxes constitutes the arrangement of elements. These arrangements may be considered through the flows within and between the boxes. The arrangement amounts to the order in which consideration may be given to the elements and their relationship to each other. Flows permit the consideration of a great variety of relationships and viewpoints. Changes in the elements, their rearrangement, and changes in flows, extend the opportunities for consideration of alternative relationships. Such a framework is suited to the representation and evaluation of legal choice. Input may be cast into elements of choice and their relationships. Output directions may be formulated in terms of choice elements and their relationships. If legal choice is represented in the system in this way, then input will be evaluated in terms of survival; the output will constitute the selection which will achieve the purpose of the system, as well as maintain the stability or evolution of the system.

The nature of the flow courses and the information processing thereby permitted, provide resources for the achievement of the purpose of the system. The input problems and the output directions determine the interaction of the system and its environment. The receipt of input and the formulation of output amounts to the communication between the system and the people who are to give effect to the system. The attainment of the purpose of the system reinforces the niche of the system in its environment. Output directions pass through the people box and may then enter the environment of the system and become effective in the physical world. Directions from SURMET may operate as stimuli or motivation to a person to behave in a certain way. SURMET is an entity of the collective consciousness which may constitute an individual thinking system, or, a common reference system through which people communicate and reach an understanding. In either case it exists in the metaphysical domain, and can only be effective as an idea. Ideas are probably maintained by physical energy states. They may also represent energy states of the physical world. In the form of motivation or reason for behaviour, ideas may also, to some extent, control physical energy states.

SURMET is posed as a metasystem for social co-ordination. It could also be adopted as a system of personal jurisprudence and be used as a metasystem of individual personality. Implicit in this is a theory of personality. Creative psychology might study how personalities can be created, by way of supplement to clinical psychology which seeks to 'cure' personality disorders. In the words of Aaron Sloman:

Progress in philosophy (and psychology) will now come from those who take seriously the attempt to design a person.(21)

The flow of a conceptual system might constitute personality games. It is important that any holistic jurisprudential view of social life, include a concept of human personality so that the law may be seen in relation to human personality or within human personality. The law must be suited to human personality and human capacity.

The purposive nature of the system, its homeostasis and its heterostasis imply methodology and determine the scope of the methodology in the system. The purpose of the system is achieved partly through the creation of expectations and reliable predictions. In order to create these expectations and predictions, the system must maintain effective information and communicate it. The nature of the open metasystem introduces environmental interaction as part of the methodology by which the system's purpose is attained. The processing of input and the formulation of output must attain the purpose of the system. The

differentiation of the macrostructures of information as the domains of boxes 1-13, is the static strategy for attaining the purpose. Any resources and operations which might be useful to the system may be incorporated and schematized in these realms of data and intra box flows.

Flow within and between boxes is somewhat like a somatic circulatory system, largely dependent upon the impetus of the central control, the heart of the matter. The flow courses are indicated by the arrows in the Figure 1 diagram. There is a two-way interaction between the central control and each other box except for the legal problem box. The task of the system is to deal with the legal problem and the nature of the legal problem can not be altered without proceeding through some other resource. The central control can structure the problem, or it may discard the problem into the entropy box. The central control may process the problem as entropy, and then take it through a restructuring in the knowledge box so that it may be returned to the legal problem box in a form which can be further processed.

There is a two-way flow between the knowledge box and the evolutionary principles box, between the people box and the environment box, and between the sub-system box and the sub-system ethics box. Evolutionary principles must be consistent with knowledge, and evolutionary principles require that the system use knowledge as a survival method. Interactions between people and their environment are represented by the flows between the people box and the environment box. Sub-systems and their ethics must be consistent; sub-system ethics are derived from the sub-system box by converting the linguistic form of the information from sub-system form to ethics form. This conversion is required to give effect to the system purpose. The central control carries out the conversion process. These flows demonstrate both the strategy and the methodology of the system.

The major flow from the legal problem box is through the legal sub-system and directly on to the sub-system ethics, expectations, and directions for implementation. These directions may then be addressed to persons in the people box, being either the person who submitted the problem or someone else. An evaluation of the

problem, and its solution, in terms of the remainder of the system may be made by reference to the additional flow via evolutionary principles, knowledge and evolutionary ethics. People may be given reasons for the directions which can be traced into the balancing of personal and social needs and wants in the evolutionary principles box. The schematization of these needs and wants as set out above, permits a person to see clearly the priorities which the consequence of any rule of law has given to the needs and wants of each of the parties to a conflict.

Knowledge may be required in order to formulate expectations and directions. This may be obtained through the flow from the knowledge box to the boxes of expectations and directions. In particular, a knowledge of communication forms may be required. Expectations may be transferred to the knowledge box via the flow which permits this. There, the expectations may be evaluated in terms of knowledge, as a double-check on the consistency between knowledge and the evolutionary principles and ethics from which expectations are derived. Through the evaluation flow, the application of evolutionary principles and ethics may be adjusted to produce different expectations.

The general jurisprudential system provides an orientation and systemic resources for the particularisation of specific jurisprudential systems. The potential for specific jurisprudential systems, which would be contained in Box 4, collateral to the positivist legal system, may be understood by three approaches:

Firstly, the various perspectives of law which each person, in different circumstances, may have, could be used as the basis for developing specific jurisprudential systems, so that the legal relativity of the individual's circumstances and, within this context, the legal choices of the individual, may be understood. Such systems may be in the nature of exploratory or learning systems which permit the user to find out what the law is and where the user may be located in the legal process; or they may be in the nature of legal advice. The advice may be given through formalised taking of instructions and then the communication of

the effect of the law in the user's situation, and any alternative courses of behaviour open to the user.

Secondly, within the general jurisprudential system, the various boxes offer many different perspectives from which to examine the legal system. SURMET may be seen as a rhetorical system. The different perspectives are cognitive choices for viewing and evaluating legal choice. For instance, a sociological view of the law, which might be derived from the knowledge box, may seek to construct a specific jurisprudential system which deals with legal information as a matter of social bonds, social organisation, social contract, social control, alienation, anomie, social sanction and so on. From the discipline of economics, lexeconomic systems may be developed. Further systems may then be developed to reconcile sociolegal and lexeconomic systems. In this way, interdisciplinary resources may be tapped.

Thirdly, specific jurisprudential systems may also be developed to aid in the formulation of legal argument and in judicial decision-making; these systems might provide an opportunity to test hypothetical law in relation to existing law. Such systems might portray the totality of legal relativity in both static and dynamic forms of choice, order and priorities. The system of legal relativity, rather than positivist theory, might be treated as the ultimate legal information which is to be implemented or adjusted.

In order to demonstrate further development of the system two tasks involving specific problems of legal choice, are considered: the exercise of welfare administrative power, and business planning. These tasks are sometimes viewed as the extremes which the legal system must serve: the poor and the rich. This is of course simplistic, but it serves to establish the scope for development of the system and how two disparate interests may be reconciled by a systemic approach. The benefits of a collective human intelligence may be available to everybody equally. It may even be that in this reconciliation, the rich and the poor may find new mutually beneficial forms of co-operation. If the rich could exploit the poor in such a way as to improve the

lot of the poor, then perhaps a new social harmony can be achieved.

Welfare Equity

It could be said that the judiciary exercise welfare power. In addition to this tradition of law, the welfare state of the twentieth century has been created through the legal system by the introduction of legislation which gives legal decision-making power to welfare administrators in certain areas. These administrators may distribute funds, from state revenue, according to the legislative provisions. Welfare schemes of the legislature allow for a more extensive redistribution of wealth than the traditional redistribution between litigants through court orders. The law has a both a macro-redistribution scheme and a micro-redistribution scheme. Welfare administrators may also intervene in personal affairs to give effect to other legislative welfare schemes such as slum clearance, state care of needy children and quality control of consumer products.

Welfare administrators should have a knowledge of the proper procedure for making an administrative decision, according to the tenets of administrative law. They must first determine the source and nature of their power, and how it should be exercised. Next, they should make a thorough investigation of relevant matters, adhering to any procedure which is required by the legislation or by the rules of administrative law. On completion of this investigation, they should make a rational decision on the basis of the power and the investigation. There should be reasons for the decision, especially if the rights or interests of individuals are affected. Within this framework there is usually some opportunity for the welfare administrator to consider and apply the principles of human welfare.

In terms of the SURMET framework, a judge exercising welfare power, or a welfare administrator, receives a legal problem (Box 3) involving certain people (Box 2), and perhaps somehow particularly concerned with their environment (Box 3). Instructions are formulated in the environment box and in the people box. Then the matter is structured as a legal problem in

the legal problem box. The relevant rules of law or legal norms, including the principles and maxims of equity, are selected from the sub-systems box (Box 4), together with the relevant legal choice schemata which applies to the individuals concerned. The purpose of the judge or administrator is to resolve and prevent human conflict (Box 7), through the exercise of the administrative power (Box 4). The judge or administrator may then consult the relevant evolutionary principles (Box 8), and consider the needs and wants which the individuals concerned are seeking to satisfy through the exercise of the administrative power (Box 3). The opportunities for satisfaction of these needs and wants, which each party has, may be taken into account, in relation to the schemata of legal choice. If necessary, the judge or administrator may return to the people box, or some other box, for further information.

A judge or welfare administrator has the opportunity to develop a welfare equity, through decisions which will, wherever possible, give people equal opportunities for satisfaction of personal needs and wants. If these opportunities are taken, people will enjoy an equal satisfaction of needs and wants, according to what each individual nominates as personal requirements. Sometimes legislation provides privileges to balance substantive inequalities. Where equality is not possible, the judge or administrator should seek the solution with the least inequality. For instance, in custody disputes between parents, the decision must inevitably produce inequality in child care and the enjoyment of parenting. The welfare task is to discover the solution with the least parental inequality, consistent with the optimum welfare of the child.

Through the exercise of welfare power, decisions might be taken to secure trust, not just in respect of property, but also in human relationships. The principles and maxims of equity may be used in new ways, especially in the exercise of administrative and quasi-administrative welfare power, to achieve welfare equity results. Equity has its origins in the Aristotelian provision for necessary exceptions to rules: it originates in diversity and deviance, and tends to widen and refine legal choice. Welfare administrators might adopt new forms of dispute resolution to

resolve conflict. The administrator might work through the conflict with the parties, step by step, from time to time, until the parties are no longer in conflict. The maxim that equity acts in personam might mean, for welfare equity, interactive mediation in the course of investigation of a case. Welfare equity might be interactive.

Welfare equity may be established in the sub-system box as a collateral welfare system which aims to produce a substantive equality of individuals, namely equality in the opportunities for satisfaction of personal needs and wants. This is a system of welfare equity since it extends the procedural maxim that equality is equity to the substantive equality of human welfare. However, there are obviously limits to achieving this equality. Where personal requirements conflict, welfare decisions may inevitably increase inequality. Sometimes welfare equity entails substantive inequality. This is usually the case in a custody dispute, where one parent must inevitably lose the benefits of custody. Welfare equity can only uphold the achievement of substantive equality as far as it is practicable.

From the position of the central control box, the administrator can select relevant information from any other box, and formulate the output which will achieve the system purpose in accordance with the requirements of the sub-system box and the evolutionary principles. Reasons may be formulated in terms of the relevant rules of law which have been applied, as is customary. All relevant knowledge and ethics may be considered, consistently with these rules, to produce an informed decision.

The resolution of human conflict entails the resolution of an agreement between the parties to the conflict. This agreement may be entered into willingly, or it may be a reluctant compromise. Agreement, trust, care and good intent, are the key concepts of judicial law which fashion the resolution and prevention of conflict. Contract law secures the fabric of social interaction which is essential to human survival in a scientific age. It might be regarded as the primal social law. This can be seen in the following aspects of contract law:

1. Private Law.

The basic premise in law is that people are free to do whatever they like, subject to the law. Contract law defines the freedom to make private law. It is therefore a fundamental area of law in social organisation. In the words of a leading text on contract law:

The state, as it were, delegated to its members the power to legislate. When, voluntarily and with a clear eye to their own interest, they entered into a contract, they made a piece of private law, binding on each other and beneficial alike to themselves and to the community at large. The freedom and the sanctity of contract were the necessary instruments of laissez faire, and it was the function of the courts to foster the one and to vindicate the other.(22)

2. Social Contract.

The eighteenth century social thought which regarded social organisation as being founded upon a social contract set the stage for the development of modern contract law in the nineteenth century.(23) The notion of the social contract carries the idea of a social bargain. Law might be regarded as the particularisation of an implied social contract. As a social bargain, it must provide greater survival opportunities than anarchy. Furthermore, the consideration moving from each party, and the terms of performance, must amount to a fair exchange. Otherwise there might not be voluntary compliance with the contract, and there may be a refusal to honour the bargain. The law is in the business of social commerce. The rules of contract law might be used to judge the performance and products of those who make law.

Contract law may be regarded as the particularisation of the implied social agreement to permit scope for private law, or diverse personalised express or implied social contracts. Contract law regulates a wide range of social interaction, from matters of business and employment to cohabitation agreements of de facto spouses. If the undertaking to exchange by agreement is the fundamental social bonding, then contract law is the core of human survival law. The struggle of human life is the struggle to

make exchanges. Social behaviour is a matter of exchanges by agreement, negotiation to prevent or resolve conflict, and thereby, the fostering of individual energy and identity.

3. Extends to Other Law.

Law, other than contract law, may be seen to restrain various aspects of the freedom to make private law: it imposes certain behavioural standards in the domain of freedom. Thus, the law of torts will apply to provide remedies where there is no express or implied agreement between parties, or where something tortious has occurred during a contractual transaction. The domain of freedom is qualified by the broader social contract that each person will be careful not to harm a neighbour. Criminal law and property law arise, similarly, as the standards of the broader social contract which qualifies the freedom to make private law. Some areas of law may directly limit contractual arrangements. For example, trade practices legislation makes compulsory certain terms about the standard of products or services supplied, pursuant to certain contracts, and further limits the subject of agreements which have certain price-fixing effects or which produce coalitions that hinder the free market. Contract law is a suitable core from which to expand into all other areas of law. Other areas of law may have a bearing on contractual choices so that the broader social contract must be taken into account in contractual transactions.

Welfare administration is ancillary to the contractual infrastructure of society. The formulation of a network of jurisprudential systems of legal choice should begin with contract law. This is the approach taken in the legal expert systems project, CLIMS (Contract Law Information Management System), which was undertaken in association with this thesis. The CLIMS Project is discussed in Chapter Seven.

Business Strategy

Business people usually wish to maximise profits and minimize risks and losses. Legal choice strategies may be developed within the framework of SURMET, to assist this sort of minimax business

planning. Business goals may be pursued in accordance with evolutionary principles and the sub-system of welfare equity. The major area of law which fashions business transactions is contract law. Strategies for minimax management of contractual transactions may be devised as legal choice systems in the sub-system box, consistently with the welfare equity sub-system and with evolutionary principles.

Contractual transactions involve at least two parties (Box 2) and are subject to environmental conditions (Box 3). Some of the rules of contract law, for example, the doctrine of frustration, provide for the effects of vis major and other circumstances over which the parties have no control. Other rules deal with the relative control of parties to a transaction. A contractual transaction is like a game. Legal games are a form of jurisprudential system. As a background to developing a contract choice system, game theory should be considered.

Game Theory may be examined in various ways as follows:

1. Definition.

Game theory, as it was developed by John Von Neumann, has been described as:

The general theory of the rational behaviour of two or more people in circumstances where their interests are, at least in part, conflicting. (24)

Prima facie, a contractual transaction is a matter of cooperation and mutual benefit as between the parties. Nevertheless, the parties may fall into conflict.(25) In a sense, the profit of one party to the contract is inevitably a loss to the other. In the exchange of consideration each party might attempt to get more than is given in return. Contract law contains the strategies by which the parties may maintain a mutually satisfactory arrangement. It assists in planning the avoidance and resolution of potential conflict. If a contractual transaction is a game, then it can be played as an agreement game or a peace game. Strategies could be developed to enhance the mutual benefit of the contracting parties, and to share equitably the risks and losses.

The evolutionary principles of Box 8 could guide the development of these business games. Profit can only be maximised to the extent that the social ecology permits. The more customers, the greater the profit. The more that customers are wealthy, the greater the profit. The more transactions the greater the profit. A system of business ethics may be formulated from the evolutionary principles and located in the sub-system box as collateral to a minimax legal choice system.

2. Origins.

Human games and the study of human games have early origins. The need for a theory of games in relation to social behaviour, was recognised by Leibniz. He thought that human life could be represented by games combining skill and chance, and that such matters could be studied with the assistance of mathematics.(26) Von Neumann was a mathematician and his work opened up dimensions of game theory which may yet give new meaning to Roscoe Pound's concept of social engineering. With the economist, Oskar Morgenstern, Von Neumann applied his game analysis to economic behaviour. Concepts were developed to describe different sorts of games and different operations within games.

3. Strategy.

Von Neumann and Morgenstern developed the notion of strategy in relation to games. The effect of this was to extend a predominantly military idea to a wider range of applications, including the maintenance of peace. Law may be seen as a social strategy and, within the law, further strategies may be available to the individual. The extensive descriptions by the law of social phenomena, and of the scheme of organisation of these phenomena, both in static and potential terms, provides for game theory the sort of finite body of information which it may now process with the aid of computers. The consequences of this is that many alternative perspectives of law can be considered and used. At the same time, this offers a new paradigm for justice in the satisfaction of needs and wants.

4. Optimal Minimax Strategy.

One of the concepts developed by Von Neumann is the optimal minimax strategy which combines the notions of rationality and utility in dynamic dimensions.(27) By this, the player seeks the strategy which will provide the best opportunities for maximising his gains or benefits and for minimising his opponent's opportunities to reduce those gains and benefits.(28) The other player's strategy is thus relevant in determining the particular aspect of the minimax strategy which will be played from time to time. Von Neumann examined the use of mixed strategies that exploit probabilities and camouflage strategies. These ideas provide perspectives from which to examine the application of rules of contract law to contractual transactions.

5. Decision Theory.

Game theory is closely associated with decision theory in both the broad decision-making sense and the narrow statistical sense. In the words of Von Bertalanffy:

Axiomatically, game and decision theory are concerned with 'rational' choice. This means a choice which 'maximizes the individual's utility or satisfaction', 'that the individual is free to choose among several possible courses of action and decides among them at the basis of their consequences', that he 'selects, being informed of all conceivable consequences of his actions, what stands highest on his list', he prefers more of a commodity to less, other things being equal', etc. Instead of economical gain, any higher value may be inserted without changing the mathematical formalism.

The above definition of 'rational choice' includes everything that can be meant by 'free will'.(29)

Where there are alternative moves in a game, then a decision about selection is required in order to make a conscious selection. Information which is relevant to an evaluation of the alternatives and the consequences of selection of any, must be understood if an informed or rational decision is to be taken. The concepts and methods of game theory may assist in the decision-making process.

Maurice Peston and Alan Coddington describe the relationship between decision theory and game theory as follows:

Thus the elements of a theoretical framework for the analysis of inter-dependent decision-making problems would be as follows:

1. Decision-makers faced with
2. Choices which jointly lead to
3. Outcomes among which each decision-maker has
4. Preferences

(In game theory terminology, the decision-makers are called 'players', the choices are called 'strategies' and the preferences of the decision-makers are represented by 'utilities' or 'pay-offs').(30)

Inter-dependent decision-making is a matter of inter-dependent preferences and inter-dependent strategies. Decisions in law are usually associated with the judiciary; but in fact, the law relates to many different sorts of decisions. Judicial decisions are about other decisions. The law prescribes what decisions people may make and the consequences of those decisions. In a legal choice system which incorporates the dimensions of legal relativity, it is recognised that each party is in an ongoing process of decision-making in relation to each other party.

The law provides concepts and rules of decision-making for individuals so that conflict may be avoided or resolved in social interaction. These concepts and rules may not be fine-tuned to the actual dynamics of society. It may not provide for every course of choice that leads to conflict. However, actual conflicts have produced the law. Furthermore, the law relies upon uniform principles so there may be a common reference point for social agreement and order. Conflict is simplified by principles of law. Principles are stated as an independent and objective form of knowledge that can be applied to categories of conflict at any time, and accommodate all the different perspectives of the conflict. One of the problems of contemporary times is that the law has become so complex that it not so easy to see the relevant law in relation to a particular situation and the variety of perspectives of that law which are relevant considerations in a particular situation. If parties to a conflict wish to see the each others viewpoints, it is no longer always a simple matter.

In the current complexity of the law, it is also difficult to see the effect of the rules on the satisfaction of needs and wants of the parties in conflict, and how the rules might be evaluated in these terms. Rather than being the rules of the game, the law is becoming a massive camouflage for another game that is difficult to see.

6. Equilibrium.

Game theory contains a notion of equilibria, described by Morgenstern as follows:

It is the entirety of the actions of the players - and of chance if nature intervenes - which determines the outcome and the equilibria (which the theory is to determine). In the course of a play, the interests of the players are sometimes opposed to each other, sometimes parallel.

The significance of game theory is that besides explaining games proper, suitable games can be identified strictly with important other human actions which they therefore model... If a theory of such games can be established then a theory for the modelled processes is obtained... our acts are interdependent in very complex manners and it is the precise form of this interdependence that has to be established.(31)

Equilibria has long been symbolised in the scales of justice. The application of game theory to law may very well open up dynamic forms of justification for judicial decision-making. At present, the judiciary is confined to theoretical consistency and abstract values, which have recently been undermined in the face of multi-perspective analysis and advancing scientific standards.

7. The Medium of Communication.

Game theory has been treated as largely mathematical and it has been recognised that there needs to be extensive development of mathematical techniques if it is to accommodate the social sciences.(32) However, whilst mathematical techniques may be of assistance in some aspects of games, other forms of evaluation and other languages may be required for other aspects of games. The language of the law must clearly indicate meaning in terms of

behavioural implications.(33) Any mathematical description of law must ultimately be interpreted in behavioural terms.

8. Teleology and control; utility and rationality.

In the application of game theory to law, the role of teleology, control, utility and rationality in both game theory and law, should be considered. Teleology in game theory is associated with the utility aspect of strategy: strategy is useful to achieve the purpose of the game. The rationality aspect of game theory is related to the control which strategy permits: it is possible to devise a strategy which will provide control over the game. It might be said that, in game theory, rationality which is particularised in strategy, or the methodology of control, serves or is the methodology of utility. Rationality is needed to devise a strategy which will provide control over the game, and to constitute the method that will achieve the purpose of the game. If human activity, is open to interpretation or manipulation through game theory, then it is these elements of game theory which might direct the interpretation or manipulation. Utility and rationality are long standing concepts in jurisprudence (32); but teleology and control are not generally related to utility and rationality in a game theory way, in jurisprudential studies.

9. Learning the game.

It is recognised in game theory that the rules determine the game and its outcome. Therefore these rules must be known to the players. It is a maxim of law that ignorance of the law is no excuse. However, the games of law are now beyond the comprehension of those who are expected to play. The enormous scope and complexity of the law, the lack of legal education and public access to law libraries, and the enormous cost of obtaining legal information, considerably handicaps many players. However, accessible legal information systems which use game theory to enhance advice might restore equality of knowledge to the game.

10. The supergame.

There has already been some consideration of the features of human society in relation to the limitations of game theory. It is a feature of society that there is a certain amount of cooperation between people; but society also has the opposite features of a certain amount of competition and inherent conflict between individuals. Broadly this fits with the requirements for a game. To achieve the best form of social management or optimal equilibria, there must be rules of law that will produce these opposites. Law-making is the supergame of achieving the balance of opposites. However, even when the rules are suitable for achieving balance, the game of law must still be played with appropriate skill to achieve a particular result for the individuals concerned. As noted by Peston and Coddington:

... the ability to cooperate will depend to a large extent on the ability to communicate. A failure of communication may intensify conflict.(35)

11. Paradoxes; games with no solution; games against nature.

Certain paradoxes have been seen to follow from the nature of human society, in relation to the maintenance of social equilibria, through rules of law. This is expressed by Morgenstern as follows:

... a formal system of society may be fully symmetric, i.e. give each member exactly the same possibility, such as laissez faire, and thereby have provisions of complete freedom and equality. But the possibility of cooperation via coalitions, agreements and the like produces non-symmetric arrangements so that the intent of the law-maker cannot be maintained without forbidding coalitions which then would run afoul of the principle of freedom.(36)

Similar paradoxes exist in law. For example, contract law begins with a notion of the freedom to contract. However, if the terms of the agreement are such as to exclude contractual liability (exclusion clauses which are too wide), then such terms will not be enforced. The effect may or may not be to make the whole agreement unenforceable, depending upon whether or not there would be consideration without the excluding provisions. If freedom is

qualified by contractual undertakings, then the circular paradox is converted to a spiral of necessary qualifications. It may be that paradoxes which occur in static structures such as circles, are resolved by dynamic structures, such as spirals. The static structure limits choice; the dynamic structure expands it. In this regard, it is interesting to note, firstly, the work of W.F. Lucas (1968), in regard to games that have no solution (interestingly, such games were found to require ten players) and secondly the work of J. Milnor (1954) on games against nature.

Behavioural possibility in law, as well as legal paradoxes, may be monitored through legal theory. The scope of possible behaviour is the scope of legal choice which require an appropriate scope of law. Possibility contains the practical and paradoxical limitations of legal choice.

12. Negotiation and Bargaining.

Game theory provides some analysis of the opportunity for negotiation and bargaining. The game may be to keep the game going; this is especially so in games with negative pay-offs to all, such as commercial or nuclear war where there can only be a Pyrrhic victory.

13. Indeterminism.

Game theory is able to deal with indeterministic factors, particularly probabilistic matters. However, the indeterminacy in human life is not in all respects that of a probabilistic nature. Human uncertainty arises from a lack of orientation as well as from chance factors. The law provides a stable orientation to the indeterministic nature of human life. However, legal information could provide an individual with the specific set of uncertainties relevant to the individual's positions in social interaction, so as to increase human certainty about uncertainty. This information is necessarily part of a jurisprudential system of legal choice. The pursuit of knowledge in a static or absolute form has dominated the field of learning until recently, perhaps because the stasis of knowledge optimizes human certainty. Knowledge of the constants and variables of

human life is increased by the law which itself stabilizes constants and variables to some extent. The maintenance of social stability, through law, which is manifest in the degree of voluntary conformity to the law, may very well be regarded as the game in which the solution is to maintain the game. Playing the game of law may be regarded as the purpose of the game of law.(37)

14. Jurisprudential relativity.

Just as science once used the ontology of law to produce a new paradigm or ontology of physics, namely the laws of physics, so an ontology of physics, namely relativity, may be used in jurisprudence to produce new paradigms or ontology of law, namely jurisprudential relativity and legal relativity.(38) These two paradigms of law are useful in the study of legal games. The inter-changeability of methodology and ontology, within and across disciplines, facilitates synthetic or systematic reasoning in regard to law and science.

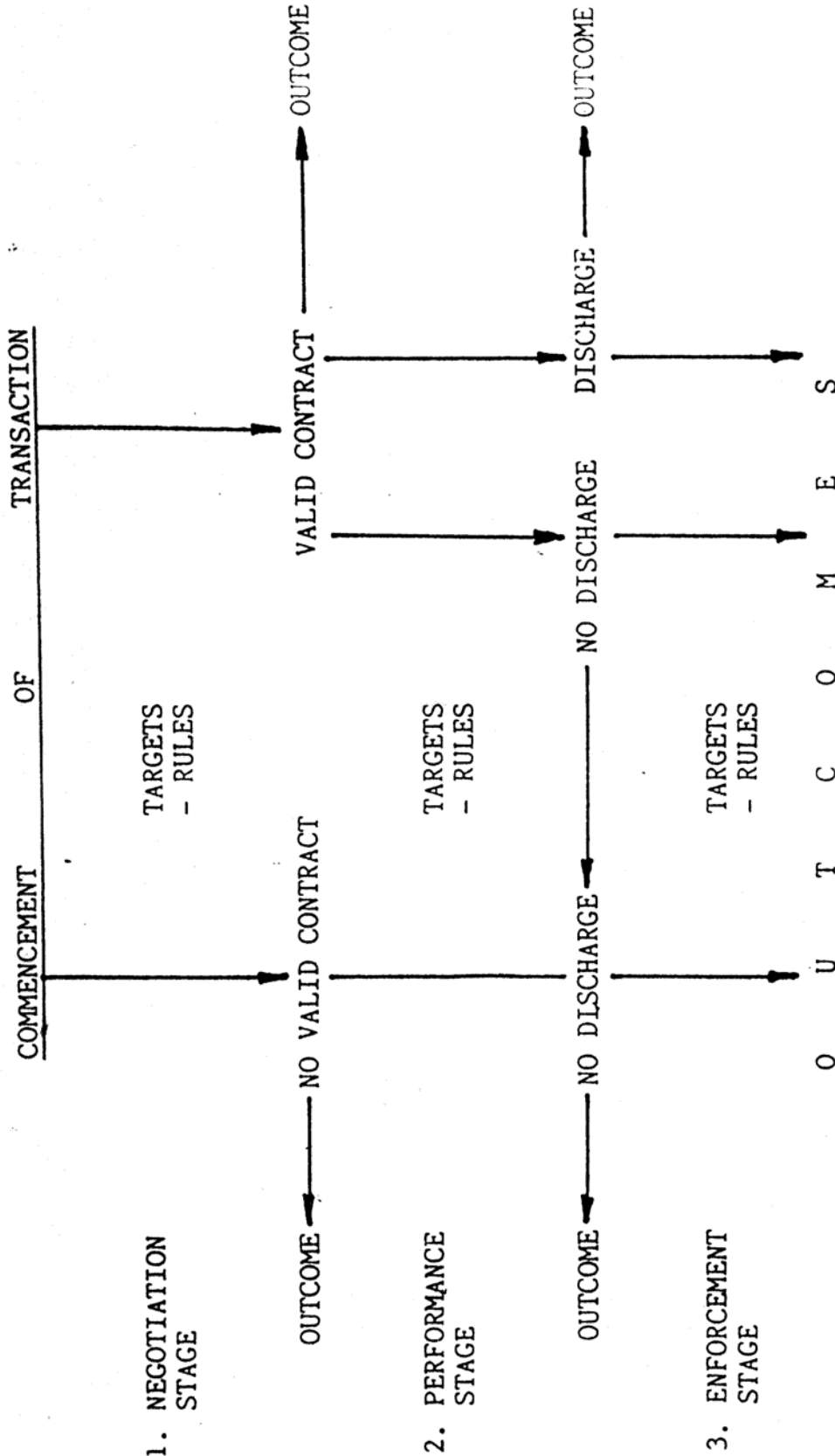
The paradigm of relativity may also be used to fashion a paradigm of information, namely conceptual relativity, as the form of meaning. It is possible to understand the dynamics of human consciousness in terms of the paradigm of relativity. Conceptual relativity depends upon how language divides consciousness, and how the consequent parts are related. Human intelligence provides an awareness of different aspects of the parts from different perspectives, and makes meaning out of conceptual relativity. Like the speed of light in physics, human intelligence might be regarded as the constant of metaphysical 'enlightenment'.(39) Choice is a function of this constant intelligence. Information is determined by the choices of language. Legal choice is specified as a meaning in legal information.

Conceptual relativity underlies jurisprudential and legal relativity. The metaphysical nature of jurisprudential relativity and legal relativity permits any aspect of any legal game strategy to be viewed in relation to any aspect of the same or any other legal game strategy. The changes of legal status, or legal position, which may occur in the course of any strategic path, in regard to the parties to the legal transaction who are on the

path, is a matter of legal relativity. The evaluation of alternative strategic paths, relative to each other, is a matter of jurisprudential relativity. Legal relativity and jurisprudential relativity are two different but related ways of determining and evaluating legal games which can be played, and the ways in which they can be played.

If individuals are perceived as operating relative strategies in the games of law, legal relativity may be further understood through game theory. The behavioural significance of the concepts and rules of law, and of the alternative courses of action which the scope of the law allows, is a basis for discovering from the rules of law, the rules of the games in law. In the field of contract law, contractual choices reveal the advantages, benefits, disadvantages, losses and risks that may be taken or avoided in a contractual transaction. Further, the contractual choices permit an appreciation of the manner in which advantages, benefits, disadvantages, losses and risks, may be controlled, maximized or minimized. A minimax contractual choice system, may be used in contract management to assist forward planning and review of the process of realisation of business goals through a contractual transaction.

In order to design a minimax contractual choice system, an initial jurisprudential systems analysis is required. This is a form of operations research in the area of law; the legal environment is examined with a view to better management of a business, or of a negotiable lifestyle such as might apply to contractual cohabitants (38) or other social groups. Contract legal information must be assembled. Next, the information must be divided into parts according to the possible stages of a contractual transaction: negotiation, performance and enforcement of a contract. At the end of each stage there are alternative outcomes. A scheme of division is set out in Figure 2. Each stage must be broken down further to accommodate the possible circumstances of each stage. A series of targets may be identified in each stage. These targets constitute alternative and sequential paths through a contractual transaction. Each path will end in one of several alternative outcomes of a transaction, the alternative ends of the game. Outcomes may be ranked as minimax priorities. Paths



Note: At any point in the transaction the parties may recommence negotiations which may produce a varied agreement (contract) - "go back to the start".

The straight lines in this diagram are in fact complex tributary structures.

Figure 2 CLIMS Design Drawing

to these outcomes may be given similar minimax rating. Once the maze is established, it becomes possible to formulate system rules or rules of the game. It might also be possible to formulate minimax heuristics, that is, rules which will secure the highest ranked minimax outcome, and, if this becomes impossible due to uncontrollable events then the next ranked minimax outcome which is possible. A contractual choice system is explored further in Chapter 7, in the artificial legal intelligence project, CLIMS (Contract Law Information Management System). In this project, a paradigm of legal relativity was developed as part of the work of this thesis. It is called The World of Rivers paradigm. This paradigm may be used in the sub-system box to structure the concepts and rules of law for a legal expert system. The structure may be processed in any of the SURMET boxes to extend the legal information to be contained in the legal expert system.

Jurisprudential systems analysis and design, in accordance with game theory, may provide some individuals with greater advantages than those who are not so apprised in legal transactions, especially if artificial legal intelligence programs are available as additional support. The law-makers and the legal profession cannot afford to be unaware of these advantages, and the basis on which they are obtained. Justice, or jurisprudential relativity, becomes a matter of preserving or modifying available legal relativity to ensure that only equitable games are available. William C. Charron summarizes this task as follows:

The Hobbesian contractarian is one who evaluates a legal, economic or political system by determining whether it is the sort of arrangement upon which the affected individuals could have come to an agreement through a bargaining effort in which each is fully aware of everyone's individual preferences and powers and each is concerned to maximize the satisfaction of his own interests. By this method of moral accounting, a social system is justified if and only if it is justifiable to each individual in that system by showing it to be mutually advantageous vis-a-vis a move to anarchy or to any other feasible social system. Today the most provocative reworking of the Hobbesian method of evaluation is being carried out by North American economists and philosophers incorporating into it central ideas of economics and the theory of games. (41)

A minimax contractual choice system could be used by lay persons, by the legal profession or by academics. It could be used as a learning system or an advisory system. For the legal profession, a minimax contractual choice system, with extensions to other relevant law, permits an evaluation of law in behavioural, management and game terms. The position of a client in relation to any rule or concept of law may be located in the system and evaluated in relation to the position of a counterparty. Available goals, strategies, choices, etc., given the alternative interactions of the parties, could be considered. The system could be an aid in devising legal argument or legal reasoning upon the basis of a behavioural evaluation of law and of a party's position in relation thereto. Clients may be advised accordingly. What would become apparent is whether the nature of the legal argument relates to challenging the rules of the game, or to the way in which the game has or has not been played in accordance with the rules. These matters might be evaluated in terms of the welfare equity sub-system and evolutionary principles.

The system of legal choice might be useful to legal and non-legal academics. The system might provide perspectives for a particular discipline. For instance, in sociological studies which attempt to examine the consequences or affects of law, a proper evaluation is required of the subjects' understanding or use of law. Criticism of the law, which relies upon behaviour that is not based upon an informed decision about the law, may not be valid, except as criticism of the inaccessibility of the law.

The law is largely the result of actual human conflict; if it is complicated, this is because the nature of human conflict and its resolution requires diverse detail. This should not be surprising when it is considered that diversification is, in evolutionary terms, often a successful survival technique. The extent of freedom in the law preserves the freedom to be diverse. A proper critique of the law should be founded upon an appreciation of its full potential rather than upon limited views. Sociological study might evaluate behaviour in relation to the full potential of law in order to evaluate that behaviour and the law.

Other disciplines might contribute to the development of the legal system by suggesting modifications to jurisprudential systems which people can use like legal advice. As indicated earlier, conceptual systems are related to personality and human mental capacity. The use of consciously devised conceptual systems or metasystems which personalise law might change the nature of human conduct in regard to the law. In particular, if the law is presented as a game that everyone can play and benefit from, it might be played between or by more people.

Various forms of computer programs may be devised from a legal choice system and provide different ways of understanding and learning the law. Learning games may be devised with various learning goals. Students may play the role of management or the role of judge and so on. There might be play with the ghost players of the computer, or there may be games for two or more real players. Games of contract management might be written for primary school ages (e.g. an agreement for the temporary exchange of toys) or for higher levels (e.g. contract for the building of a skyscraper). The forms of programs may differ in terms of learning experiences and the level of understanding and control required. Games may be designed on the basis of fixed or variable strategies. Alternatively, programs may take the form of intelligent information retrieval and processing aids. Whatever the program, tests for the user may be introduced to examine or rate user comprehension of the program.

Conclusion

SURMET is essentially a system of concepts which may be viewed relative to each other. Legal information represents a relative world or possible relative worlds. The meaning in legal information is contained in SURMET from relative perspectives. Concepts which make up the aspects of law from one perspective, may be related to concepts which make up the aspects of law from another perspective. SURMET is a system of conceptual relativity. Nested in this conceptual relativity is jurisprudential relativity, whereby the law might be evaluated in terms of knowledge, survival or evolutionary ethics. According to these evaluations, systems which are collateral to the legal system may

be developed, such as legal choice systems and a welfare equity system. Nested in the jurisprudential relativity of the system is legal relativity, whereby changes in a legal status or position may produce other changes of legal status or position.

The bridge between human needs and wants, and moral and legal principles, which was dismantled during the English period of casuistry, is restored in the general jurisprudential system, SURMET. The evolutionary principles may serve various coadapted moral systems which are the different modes of survival of people. SURMET is a information system which might co-ordinate the relative ethics of different people and determine the scope for moral diversity in the context of survival activities. Sub-systems of legal choice contain the range of legal modes of survival. Individual diversity arises in the selection from the different sets of choices that are available. Implicit in each set of choices is a set of ethics. Relative ethics arise from relative choices.

Any conceptual paradigm can be accommodated by SURMET. The paradigm of SURMET itself can be located in any of its own boxes for processing. SURMET is essentially an information system which will allow an orderly processing of any information. It stabilizes information, but has sufficient flexibility to accommodate any problem. As a design aid, it permits the construction of a wide range of artificial legal intelligence aids, so that the law can operate at the highest level of intelligence and so that everyone can enjoy equally the benefits of this intelligence.

Computers are not suitable instruments for Platonic mysticism and must be confined to available descriptions of the law, however authoritatively tenuous these may be. By venturing into the world of computers, the law enters a new stage in the development of its metaphysics. It moves from Platonic metaphysics to what might be termed information metaphysics, that is, the treatment of thought as elements, arrangements and rearrangements of elements, with reference to communication rather than perfection. In SURMET, perfection lies in survival selection rather than in the supernatural.

F.W. Eggleston proposed a view of the law which was similar to an information perspective:

The fundamental character, therefore, of a process of law-making is that, members of a community with the pattern instinctively held in their minds, contemplate the essential relations of the members, with their implications and incidents, define them in intelligible forms, keep the whole product consistent and preserve it as a support to the integrity of the group.(42)

It may be doubted, therefore, whether any legal system has been really scientific in the sense that an abstract science or physics or chemistry may be, or whether it even could be. According to our theory, it is the mere systematic expression of the pattern, and the pattern is not abstract but empirical.(43)

He saw human life as the relativity of a series of equilibriums which merge and contain relative freedom from time to time.(44)
Law and human activity occurs within this relativity of human life.

The complexity of a legal information system is captured in the mind modelling philosophy of Sloman, which is sketched in his following statements:

The development of good tools for thinking about a system composed of multiple interlocking processes is only just beginning.(45)

Since the system cannot be broken down hierarchically into parts, then parts of those parts, until relatively simple concepts and facts are reached, anyone learning about the system has to learn many different inter-related things in parallel, tolerating confusion, oversimplifications, inaccuracies, and constantly altering what has previously been learnt in the light of what comes later.(46)

Information metaphysics represents the potential and methodology of human consciousness. Jurisprudential relativity may exist in potential, hypothetical or conceptual space and jurisprudential orientations may be maintained through the systematization of thought. This form of human consciousness may be simulated in computers. If a conceptual system is so extensive as to necessitate computer aids as an extension of human personality resources, then human personality may be required to conform to computer characteristics. Information metaphysics is the

metaphysics of computer programs in their static and dynamic states.

Artificial legal intelligence might be measured in terms of the number of elements, the number of arrangements and rearrangements of elements, and the number of heuristic rules for selecting the elements and their arrangement that will constitute a solution to a particular problem. The speed of selecting and processing relevant elements to produce a solution to a problem, may also be calculated as a measure of artificial legal intelligence. A measure of choice is implicit in these measures of intelligence. Legal choice is implicit in artificial legal intelligence. As a methodology of intelligence, and as the simulation of human intelligence, artificial intelligence, may open up a new method for indirect measurement of human intelligence.

SURMET establishes paradigms of human intelligence in legal decision-making. Within a holistic system of intelligence, law can be processed so that it can be used more intelligently. It can also be modified to be made more intelligent. Human intelligence is reflected in human survival methods and the application of human knowledge. Law may be better integrated into human survival methods and applications of human knowledge. Within the framework of SURMET, the law is better placed for the design of artificial legal intelligence programs.

Footnotes

- (1) An Introduction to the Philosophy of Law, Yale University Press, New Haven, U.S.A. 1922, page 1.
- (2) See F.A.R. Bennion, Statutory Interpretation, Butterworths, London, England, 1984. In this extensive study of statutory interpretation, Bennion has collated the rules of statutory interpretation and also drawn on logic and linguistics to assist the process of interpretation and its evaluation. See also papers of the Interpretation Symposium, Southern California Law Review, Volume 58, Nos. 1 and 2, 1985; Teresa Godwin Phelps and Jenny Ann Pitts, Questioning the Text: The Significance of Phenomenological Hermeneutics for Legal Interpretation, St. Louis University Law Journal, Volume 29, No.2, 1985, 353-382; and Drucilla Cornell, The Problem of Normative Authority in Legal Interpretation, in Law and Semiotics Volume 1, edited by Roberta Kevelson, Plenum Press, New York, U.S.A., 1987, page 149.

- (3) W. James, *The Principles of Psychology*, Henry Holt, New York, U.S.A., 1890.
- (4) John B. Watson, *Psychology from the Standpoint of a Behaviourist*, Lippincott, Philadelphia, U.S.A., 1919.
- (5) Butterworths, Sydney, Australia. When the author was a law student at Melbourne University in 1962, she was asked by Professor Brett to explain why she had undertaken studies in psychology simultaneous with law studies. These studies were more onerous than other options open to the author. The author explained to the professor her long term interest in discovering the significance of law as a psychological phenomenon. Professor Brett thought that this was a promising interdisciplinary pursuit.
- (6) North-Holland Publishing Company, Amsterdam, Holland. Compare C.K. Ogden, *Bentham's Theory of Fictions*, Kegan Paul, Trench, Trubner and Co. Ltd., London, England, 1932. Bentham's theory of fictions in law stands between Occam's razor and Watkin's theory of law as social phantasy. In America, The Law and Semiotics school have sought to establish the neutral idea of signs and their effects - a stimulus-response paradigm - as the basis of jurisprudence. See Roberta Kevelson, *The Law as a System of Signs*, Plenum Press, New York, U.S.A., 1988; Roberta Kevelson (ed.) *op. cit.*
- (7) *Ibid.* page 125.
- (8) *Ibid.* page 126.
- (9) *Ibid.* page 131.
- (10) *Ibid.* page 136.
- (11) *Ibid.* page 141.
- (12) *Ibid.* page 158.
- (13) *The Golden Braid of the Law: Reasoning about Law and Computers*, Melbourne, Australia, circa 1982.
- (14) Penguin Books, Harmondsworth, England, 1979.
- (15) John Wiley and Sons Inc., New York, U.S.A., 1980.
- (16) *General Systems Theory*, George Braziller Inc., New York, U.S.A., 1968, page 112; also see pages xx and 27. See also: John Beishon and Geoff Peters (eds), *Systems Behaviour*, The Open University Press, London, England, 1972; Peter Checkland, *Systems Thinking, Systems Practice*, John Wiley and Sons, Chichester, England, 1981; Richard S. Lehman, *Computer Simulation and Modelling*, Lawrence Erlbaum Assoc., Hillsdale, New Jersey, 1977; William Gray, Frederick J. Duhl and Nicholas D. Rizzo (eds), *General Systems Theory and Psychiatry*, Little Brown and Company, Boston, U.S.A., 1969.
- (17) *Pure Theory of Law*, translated by Max Knight, University of California Press, Berkeley, U.S.A., 1967.

- (18) Random House Inc., New York City, U.S.A.
- (19) For an extensive treatment of the problem of determining human needs objectively, see Patricia Springborg, *The Problem of Human Needs and the Critique of Civilization*, George Allen and Unwin, London, England, 1981. Springborg reviews philosophies of human needs, and the political manipulation of specific needs. The list given in this thesis is merely intended to indicate a range of common needs, and is open to modification by way of improvement.
- (20) *The Prescriptions of the New Hobbesian Contractarian*, in *Law and Semiotics*, op. cit. page 125. See also Philippa Foot, *Morality as a System of Hypothetical Imperatives*, *Philosophical Review* 81:3, 1972, 305-316.
- (21) *The Computer Revolution in Philosophy*, The Harvester Press Ltd. and John Spiers, Hassocks, England, 1978, page 13. Cf. Systems ideas in the human mind studies of E. Neumann, *The Origins and History of Consciousness*, Pantheon Books Inc., New York, U.S.A., 1954, and E. Laszlo, *System Structure and Experience: Toward a Scientific Theory of Mind*, Gordon and Breach Science Publishers, New York, U.S.A., 1969.
- (22) J.G. Starke and P.F.P. Higgins (eds), *Cheshire and Fifoot's Law of Contract*, fourth Australian edition, Butterworths, Sydney, Australia, 1981, page 23.
- (23) For an overview of the great age of the doctrine of the Social Contract, see Ernest Barker's Introduction to the book, *Social Contract: Essays by Locke, Hume and Rousseau*, Oxford University press, London, England, 1960.
- (24) See J.A. Mirrlees' definition in *The Fontana Dictionary of Modern Thought*, edited by A. Bullock and O. Stallybrass, Fontana Collins, London, England, 1977, pages 253-4.
- (25) For a discussion of game theory and human conflict see K.P. Heiss, *Game Theory and Human Conflicts*, in *Methods of Operations Research*, 5, (1968), 182-204; T.C. Schelling, *The Strategy of Conflict*, Harvard University Press, Cambridge, Massachusetts, 1960, and *Micromotives and Macrobehaviour*, Norton, New York, U.S.A., 1978. See also Robert Axelrod, *The Evolution of Co-operation*, Basic Books, New York, 1984.
- (26) See study of Leibniz by O. Morgenstern, *Game Theory*, in P.P. Wiener (ed.), *Dictionary of the History of Ideas*, Charles Scribner's Sons, New York, U.S.A., 1968, page 264. Morgenstern relies upon: G.W. Leibniz, *Annotatio de quibusdam ludis*, *Miscellanea Berolinensia*, Berlin (1710) p.22 and a letter from Leibniz to de Montmort, 29th July 1715.
- (27) See H.W. Kuhn and A.W. Tucker (eds), *Contributions to the Theory of Games*, Princeton University Press, U.S.A., 4 Volumes, 1950-59.
- (28) See R.D. Luce and H. Raiffa, *Games and Decisions*, John Wiley and Sons, Sydney, Australia, 1957, for game trees defining games, and for an analysis of strategy in relation to non-cooperative and cooperative games.

- (29) Op. cit. pages 121-2.
- (30) The Elementary Ideas of Game Theory, CAS Occasional Papers No.6, London, England, 1967, page 7.
- (31) Op. cit. page 266.
- (32) See M. Shubik, Game Theory and Related Approaches to Social Behaviour, J. Wiley and Sons, New York, U.S.A., 1964, and Game Theory in the Social Sciences, M.I.T. Press, Massachusetts, 1982; also see R.M. Martin, Events References and Logical Form, Catholic University Press, Washington, D.C., U.S.A., 1978.
- (33) Cf. C.G. deBessonnet, A Proposal for Developing the Structural Science of Codification, Rutgers Journal of Computers Technology and the Law, 8, No.1, 1980, 47-63; see also H. Burkert, Theories of Information in Law, Journal of Law and Information Science, 1, No.2, 1982, 120-129.
- (34) See C.G. Weeramantry, op. cit. (1982) p.112-113, on utilitarianism and the law.
- (35) Op. cit. page 5.
- (36) Op. cit. page 271.
- (37) See J. Huizinga, Homo Ludens, Beacon Press, Boston, U.S.A., 1957 originally published in 1938, Ch. IV which deals with lawsuits as games, Ch. IX which deals with play forms in philosophy and Ch. XII which deals with business as play and play as business.
- (38) Bentham in his theory of fictions was concerned with relativity in legal information: see Ogden, Op. cit. page 109); B.N. Cardozo, in his book, The Paradoxes of Legal Science, Columbia University Press, New York, U.S.A., 1928, pages 11, 12, and 14, was also of the view that relativity might provide developments for the law.
- (39) Cf. Albert Einstein's constant of light for physical relativity, described in his two books, Relativity: The Special and General Theory, translated by R.W. Lawson, Methuen and Co. Ltd., London, England, 1920, and The Meaning of Relativity, translated by E.P. Adams, Methuen and Co. Ltd., London, England, 1922.
- (40) See Pamela N. Gray, Cohabitation Contract Precedent, and A New Lease of Life, 123 New Law Journal, 1973, 591. See also Chris Barton, Cohabitation Contracts, Gower Publishing Company, Aldershot, England, 1985.
- (41) Op. cit. page 109. A well developed legal game theory could be reconciled with the elaboration of justice propounded by John Rawls: A Theory of Justice, Clarendon Press, Oxford, England, 1972. See also David Gauthier, Morals by Agreement, Clarendon Press, Oxford, England, 1986.
- (42) Search for a Social Philosophy, Melbourne University Press, Melbourne, Australia, 1941, page 127.

- (43) Ibid. page 135.
- (44) Ibid. pages 317-318.
- (45) Op. cit. page 10.
- (46) Ibid. page 14.

CHAPTER SEVEN

LEGAL KNOWLEDGE ENGINEERING

Introduction

Computer Technology

Legal Expert Systems

The CLIMS Project

Requirements for TECLAW

Conclusion

Introduction

Computer jurisprudence is the study of all aspects of law which are relevant to computers. Legal knowledge engineering, is a field of computer jurisprudence. This Chapter is concerned with the nature of legal knowledge engineering and the development of jurisprudential systems science and the science of legal choice in the context of legal knowledge engineering. The major task in legal knowledge engineering is the automation of legal intelligence through legal expert systems. The computer science of knowledge engineering, provides a basis for the development of legal knowledge engineering. Legal choice may be knowledge engineered as a jurisprudential system. Generally, artificial legal intelligence has the systemic structures and processes of legal choice. Legal knowledge engineering methodology is a methodology for determining and automating jurisprudential systems of legal choice. Jurisprudential systems science and the science of legal choice are concerned in the development of computer jurisprudence in its field of artificial legal intelligence or legal expert systems.

Human intelligence is a high level abstract concept which is generalized from human decision-making or choice behaviour. Artificial legal intelligence is the simulation in computers of legal decision-making processes. The computer is a decisional machine.(1) Legal decisions may be taken by legal experts such as solicitors and judges, or they may be taken by lay people in the course of their business or personal lives. An informed decision is made on the basis of relevant knowledge. The knowledge of a legal expert is expert knowledge. Lay people could make informed legal decisions with the aid of legal expert systems. The construction of an intelligent legal decision aid in the form of a computer program, requires the design of specific jurisprudential systems for the process of legal decision-making or legal choice.

Although the thesis is concerned with jurisprudential expertise, rather than computer expertise, in the construction and evaluation of legal expert systems, some understanding of computers is essential to legal knowledge engineering. Accordingly, this Chapter deals initially with the nature of computer science and

legal expert systems, in order to establish a computer context for jurisprudential systems science and the science of legal choice. The further development of jurisprudential systems science and a science of legal choice is approached by reference to two major concerns in the development of legal knowledge engineering. The first concern is the need for a methodology for the construction of intelligent legal programs. The second concern is the need for a computer environment which is suited to the legal domain. These two requirements are mutually dependent. The sort of methodology needed, will depend upon the nature of the processing device which is to be used; the processing device required will have to suit the methodology which will achieve the user purpose of the legal expert system. Both of these concerns have been explored in the CLIMS (Contract Law Information Management System) Project which was undertaken in association with this thesis. The project addresses this 'recursive' problem of how and where to begin the development of a legal knowledge engineering methodology and a suitable computer environment for the legal domain. Hence, following the description of legal expert systems, the advances made in the CLIMS Project, are explained with some reference to other legal knowledge engineering projects. In the course of the project, the author developed a jurisprudential design aid which indicates the sort of processing device which is required for artificial legal intelligence. This design aid is called the World of Rivers (WOR) paradigm. It may be seen as a three dimensional flowchart or net for the management of legal choice. An early version of the design aid was used to construct a prototype shell, consisting of a system of inference engines. The shell goes some way to establishing the requirements for a Total Environment for Computerization of Law, TECLAW, system.

Computer Technology

a. Hardware and Software

All computer equipment is either hardware or software. The machinery - its components and peripheral devices - is hardware. There are three sizes of computers: mainframes, which are large installations, micros which are portable, and minis which are a hybrid of mainframe and micro. A modern computer consists of

three major components: main memory, the central processing unit (CPU), and peripheral devices, inter-connected by data channels. Its processes are sequential, according to the original design of John von Neumann.(2) Main memory stores data and programs for processing data. It is sustained by a constant source of power and its memory is known as RAM, (Random Access Memory). If the power is temporary, then main memory data and programs can be copied onto disks for permanent storage. The CPU carries out data processing according to directions which it receives from a processing program in main memory. Common peripheral devices are keyboards, mice, monitors (screens), storage devices such as disk drives and disks, printers, and modems for connecting the computer to the telephone network. The computer user operates the program through a keyboard or other instruction device. These peripheral devices allow the user to access main memory and the CPU.

In recent years, alternatives to the original von Neumann architecture have been devised to produce more powerful machines, called parallel processors. These machines have more than one processing unit. There are many different designs of parallel processing, and, depending on the number of processors, they fall into three categories: coarse-grained parallelism, which uses a few large processors; very large scale integration which effects parallel processing through banks of tiny processors etched onto a single chip; and massive parallelism which distributes miniscule processors throughout memory, so that each procesor has its own sliver of memory. The processors may be linked in different ways. In some designs, the processors are linked hierarchically; in other designs there is a decentralization of control, so that data acts like taxi-cabs ready to be picked up by a processor that can use it. Serial machines can be programmed to simulate parallel processing, but inevitably they would be slower. It may be that different machines suit different tasks. Parallelism provides a basis for multiple forms of interacting intelligence, simulating what Marvin Minsky has conceived as a 'society of mind', a sociology of intelligence.(3)

The size of a computer, and thus its capacity for storage and processing is measured by its number of bytes, kilobytes (1,024 bytes) or megabytes (1,000,000 bytes). Usually one keystroke,

which will create a character of the alphabet on the monitor screen, takes up one byte of memory. The fundamental operation of a computer is electronic control or electromagnetism, of microscopic entities, that are commonly called bits. The term bit, short for binary digit, was coined by Claude Elwood Shannon, who founded modern information theory.(4) A bit is a notional entity which is the primary unit of information in a computer. Bits are made possible by the primary physical components of the computer's memory cells and logic circuits. These primary physical components are usually transistors. The term 'transistor' is used to indicate the transfer of electricity across a resistor. Generally, transistors are made of silicon (refined beach sand), with other elements added (usually arsenic, phosphorus and boron). A transistor can switch from conducting electricity to being resistant to it. As a semiconductor it is highly efficient. If an electrical current flows into a transistor, then no current will flow out of it. It is like a gate. Once the current is halted, the transistor will generate an outgoing current. It is as if the gate has opened. A pair of transistors may give and receive electrical current to and from each other. In this sense, they retain or store a bit of information. The absence of stored electrical current in a pair of transistors is also a bit of information. A pair of transistors may be active or inactive, depending upon whether or not they are storing electrical current. These alternative states of off or on, dead or alive, represent the fundamental nature of choice in computers. The choice is fundamentally binary. The active or inactive state is their binary characteristic. The language of computers is fundamentally binary code, which is represented mathematically as 1's and 0's.

A vivid analogy to transistors and bits of information is given in the street light description of Peter B. Maggs and J.A. Sprowl:

Deep down beneath all the layers of software and hardware, deep within all the integrated-circuit logic chip packages, lie the "atoms" from which all digital computers are constructed - the transistors, which are called "gates." It is difficult to describe these transistor gates, since they contain no moving parts that are readily visualizable. They are best described by analogy to something more ordinary and

familiar - something that actually could be used to construct a digital computer - street lights.(5)

... Visualize, if you will, a street light constructed from a light pole from which extends, outwardly and upwardly, a four foot long arm bearing a light that faces down toward the street. An "electronic eye" is mounted on the tip of the pole, away from and slightly below the light, facing the sky. Such a street light is analogous to the transistor gates that constitute the basic building blocks of all computers.(6)

The electronic eye turns the street light on or off, depending upon whether it is dark or day. Maggs and Sprowl explain the nature of a bit and computer memory by introducing to the analogy a child with a torch and two street lights facing each other, the first one on and the second one off.

The child climbs up the pole of the first street light and shines a very brief pulse of light upon the first light's "electronic eye." In response to this pulse, the first street light turns off (thinking the sun has come up) and leaves the "electronic eye" of the second light in darkness. The second street light then turns on (thinking it is night time) and illuminates the "electronic eye" of the first street light, locking the first street light off even after the child extinguishes the flashlight. ...

If the child were now to climb the pole of the second street light and shine a pulse of light on the second street light's "electronic eye," the two street lights would revert to their original state with the first light on and the second light off and remain there.

We have created a "memory"- a pair of street lights that "remember" which "electronic eye" was illuminated most recently.(7)

In the computer's memory, a pair of transistors, effectively, is a bit. An array of eight bits constitutes a byte. Each bit may be turned on or off, so that, in a byte, there are 256 alternative combinations of on or off. One byte can store one of 256 different messages. The binary code can be used to produce 256 alternative messages. So binary mathematics may be used to distinguish 256 qualitatively different messages. Bytes may be used as symbols of numerical or non-numerical things. A computer

keyboard is connected to eight signal wires. Each keystroke creates, in a byte, a different pattern of on and off bits. When any key is struck by the operator, eight bits are programmed by the signal pattern to represent the character, sign or number of the key. A memory pattern is activated by the signalled pattern. In the array of eight bits, some cells will be on and some cells will be off. If the various combinations of on or off switches are regarded as symbols of 1's and 0's, then for each keystroke, there is a pattern of 1's and 0's. A byte is a vector of 1's and 0's. Each byte holds a single datum, which may be a symbol. A string of bytes or symbols may represent some meaning or human information. They may make up an English word or some mnemonic abbreviation or acronym. Chunks of symbols may represent human language text: either a single word or more extensive text. In a program, chunks may be treated as a single whole; or they may be examined for their content. In a computer program, every qualitative message has a mathematical definition in binary code.

The street light analogy also explains the use of transistors as the signal paths or communication networks which connect memory cells.

Next, pretend that there are 99 street lights spaced four feet apart. Each street light is turned sideways so that its light shines directly into the "electronic eye" of the adjacent street light. It is still a dark night, so the "electronic eye" on the first street light receives no light, and accordingly the first street light turns on. The first street light shines directly down on the "electronic eye" on the top of the second street light, and this illumination causes the second street light to turn off. The second street light leaves the "electronic eye" of the third street light in darkness, so the third street light turns on. The light from the third street light causes the fourth street light to turn off, and the absence of light from the fourth street light causes the fifth street light to turn on, and so on. As you can see, street lights 1,3,5...99 are turned on, and street lights 2,4,6...98 are turned off.(8)

One street of lights can be controlled by adjusting the environment of the first street light, so that it would turn on and off like a flashing signal which would pass down the path of street lights. Paths of transistors can be configured in many

ways. Memory cells may be located adjacent to signal paths and control the flow of signals, by an adjustment of memory. Maggs and Sprowl represent this in the street light analogy.

The pair is positioned so that the first street light in the pair shines directly down on the "electronic eye" of street light number 20 in the row of 99 lights. If the first street light in the pair is off and the second is on, then the street light pair has no effect upon the 99 streetlights ... But if the first street light in the pair is on and the second is off, then the light from the first street light in the pair illuminates continuously the "electronic eye" in street light number 20 and keeps street light number 20 turned off... In practical effect, the "memory" pair of street lights can "connect" or "disconnect" the ... signal path...(9)

Bits may be used as logic gates that link or separate information. Gates may enclose or link strings or chunks of bytes, setting parameters. By the adjustment of memory cells, a digital computer is programmed to carry out information storage and processing. The hardware has its own system of digital logic. There are many choices about the arrangement and rearrangement of bits and bytes of information, which extend the potential communication of the computer. The determination of these choices as a sequence is the programming of the computer. A computer program is known as software; it deals with data as metaphysical symbols.

There are various levels of specialised programming which convert the binary digit 'language' of the hardware into human language and artificially intelligent processes. Hardware is designed by electrical engineers who produce the first programming language, known as the microinstruction language, or microcode. This consists of an initial set of controls or commands which will instigate on or off switching in the memory banks and circuits. These controls can establish gates which may be open or closed, and accordingly control signal paths. Bits are used to make up the 'sentences' of the computer which act as instructions to carry out a process of change in the state of memory cells and signal paths. Microcode sequences define functions which the computer can carry out, such as addition, subtraction, fetch, store. The

sentences of microcode become the definitions of the words of machine language, or machine code which is sometimes regarded as the lowest computer language. A further set of commands which are built from microinstructions, may be used as assembly language, to build further programs with more controls or commands. Assembly codes may be used to devise new processing functions. Software engineers use machine language and assemblers to develop higher languages. Languages are programs and they permit the development of further programs which might be further languages. The levels of computer languages are described by Maggs and Sprowl as follows:

Sociologically, everything from the "machine language" level on down to the transistor gate level falls within the general province of the electrical engineers, while everything from the machine language level on up to the user falls within the domain of the computer scientists.(10)

The information of bits also may be recorded as magnetic memory on disk or tape. The plastic material of the disk or tape is coated with oxide of iron. The data in main memory can be recorded onto a disk through a disk drive. The head of the disk drive is an electromagnet, the magnetic field of which is modified by the electrical process of recording data. As the head passes over the tape or disk it magnetizes the iron particles according to the changing state of its magnetic field. The changing state of the magnetic field is determined by the state of the computer memory banks. A track of magnetic memory is left imprinted on the tape or disk and can be read back.

Computers are programmed so that they can be operated through peripheral devices. These programs are known as operating systems. Software is created to suit particular operating systems, such as PC-DOS which is a widely used IBM system. The design of a computer system at the level of bits and circuits, and operating systems determines the scope for alternative programs at higher levels. Fundamental designs may optimize the efficiency of a higher level program or service. Lower level languages are used to create more and more specific programs at higher levels. Programs called compilers convert high level language programs

into machine language so that the high level programs can be run. Some computer systems may have programs called interpreters which interpret high level languages into low level languages so that high level programs can be run; this is usually slower than a compiled program.

Computer languages are the tools for programming computers to carry out the services of storage and processing of human information. Programs work on stored data and input data to provide output data as the service. The output data may be data retrieved from stored data, processed input data, or some combination of retrieved and processed input. The data and the processing might be quantitative or qualitative in nature, or some combination of the two. Although the binary code might ostensibly confine artificial thinking to quantitative processes, in fact, recent developments have greatly extended the opportunities for qualitative reasoning based on binary quantitative processes. The use of bytes to create English words, or symbols for English words, permits the construction of symbols of qualitative meaning as data. The processing of bytes of data can simulate qualitative reasoning. To achieve this simulation, data may be related so as to form data structures or symbol structures. Processing of data structures is controlled by algorithms which determine the choices that will produce a sequence and arrangement of retrieved data. In this way, quantitative processing acts as qualitative processing.

Algorithms constitute the control strategy of the system. They determine the selections and rearrangements of data as the order of processing. The computer discriminates data by virtue of the control strategy. The form of control indicates whether the language is a procedural language such as BASIC; a functional language such as LISP; a description language such as ID3 the input formalism of which is a feature vector that is processed by the rule formalism of a tree; an object-oriented language such as Smalltalk; or a declarative language such as PROLOG (PROgramming in LOGic). PROLOG can also be used as a high level procedural programming language. This variety of languages provides for a range of symbol structures and processing to accommodate different sorts of information processing.

Software uses the potential logic of hardware to simulate the logic of human information. It determines the design of human information which will harness the hardware system. In the design of software there is a choice about the nature, arrangement, and rearrangement of human information. A difference between data and useful information is described by T. Stonier as follows:

Data may be converted to information by analysing it, cross-referring, selecting, sorting, summarizing, or in some other way organizing the data. Information is more valuable than data. It is data transformed into a meaningful guide for specific purposes.(11)

Through computer languages, bits and signal paths are used to create computational models of the structures and processes of human thought. Hardware provides the environment for meaningful software services which are beneficial to users.

In legal knowledge engineering, the units and logic of the metaphysical world of law is configured to the units and logic of the digital physical world, so that the machine behaves as if it has some sort of legal intelligence. The location and pattern of information, in both the physical and metaphysical senses, is the basis of a program. When software is loaded into a digital computer, the information in the software sets the memory cells of the hardware. As the program of the computer, the software choices set the hardware choices. An integral aspect of software design is choice; the program is the sequence of choices about computer and human information within the framework of data structures or symbol structures. Compatible software and hardware designs are required in legal knowledge engineering. Jurisprudential analysis and synthesis are required to design and draft the symbol structures which will be processed in specific ways to simulate a legal service.

Programs may be designed to carry out processes on data, so as to simulate human reasoning in the nature of either logic, or the heuristics of human experience or expertise. Heuristics have been developed by practical reasoning and experimentation in various domains. Such programs may have user interfaces, for high level

programmers, which eliminate the need for a user to deal with the various levels of computer languages. User friendly interfaces are an indication of artificial apperception in a computer. The interface presupposes lower level workings. It could be said that the metaphysics of the computer presupposes its physics. A high level programmer may be protected from the complexity of the hardware and software levels. These protective programs are called shells. A shell confines and simplifies programming. A shell might be either a high level interpreter, or, a tool for constructing a program which is then compiled to run efficiently. The compiled version may be stripped of all the building apparatus by a stand alone generator and operate as a stand alone or run-time version.

Expert system shells contain, invisibly to the user, the data structures and control strategies that operate a particular expert program. The distinction between knowledge and control in an expert system is determined by the architecture of the system. Expertise is simulated by the data structures, usually in the form of a knowledge base, and the control strategy. Hence, the data structures and control strategies must suit the domain expertise.

If a shell provides programming facilities to simulate the reasoning processes of inference, it is said to have a form of program control called an inference engine. The nature of an inference engine is explained succinctly by Chris Naylor in his article, How to Build an Inferencing Engine.

By 'engine' I really mean the system by which we shall determine - or the system shall determine - exactly what order it is to carry out its inferences.(12)

An inference engine is usually a goal-seeking device or facility. The beneficial user seeks advice on an actual or hypothetical fact situation. This advice is generated by the inference engine usually by a process of chaining through a sequence of related symbols, guided by instructions which are obtained from the user. An inference engine is usually a high level interpreter but might also work as a compiled program.

Inference engines have been developed to suit the data and expert tasks of specific domains such as medicine. However, other domains may require different inference engines. P.L.K. Jones states this as follows:

But the trade-off lies in the relative inflexibility of such a shell. If the target application is not a good paradigm of the problem for which the shell is designed, there may be grave difficulties in fitting the problem to the architecture of the essentially prespecified answer.(13)

There are indications that the legal domain requires a more complex system than has so far been developed. In the field of knowledge engineering, many domains have been explored and many different forms of knowledge processing have been posed. There is not yet a program which claims to be able to handle all knowledge domains. Furthermore, there is no consensus about a generic knowledge structure or processing device. Chris Naylor puts it this way:

After all, suppose that you had just such an inferencing engine and that you had, also, a knowledge base applicable to the field of medical diagnosis. Why waste the engine at such time as you wanted an expert on, say, weather forecasting? Why not simply unplug the medical bit and design and plug in the meteorological bit? Well, the reason 'why not' is simply that - as yet - your inferencing engine might not be up to handling knowledge from two such disparate fields.(14)

It has not yet been determined if there could be an inferencing process common to all expert domains; nor is it clear to what extent the monotonic inferencing process can be adapted to suit the non-monotonic reasoning which appears to be used in the legal system. Monotonic means one-directional: increasing or decreasing. Reasoning is monotonic if new axioms increase but do not reduce the theorems which they prove. Most logical systems are monotonic in the sense that adding more axioms will always increase the number of proveable theorems. Non-monotonic reasoning may reduce proveable theorems through the addition of new axioms. In non-monotonic logic, some theorems may be lost by

the addition of new axioms. If the paradigm of monotonicity is applied to legal choice, then the alternatives take the place of axioms and the consequences take the place of theorems. So, monotonic legal choice remains stable even where new alternatives and consequences are added. In legal reasoning, new alternatives and consequences may affect existing alternatives and consequences. This may be regarded as non-monotonicity. However, settled law may be regarded as, prima facie, monotonic. The World of Rivers paradigm introduces a notion of elasticity to expand or contract alternatives or consequences. Algorithms for elasticity may provide for non-monotonic reasoning.

Two-valued logic (e.g. true or false), three valued logic (e.g. yes, no, or unknown), four valued logic (e.g. true, false, unknown or absurd; minimax contract, minimax non-contract, non-minimax contract, or non-minimax non-contract), multi-valued logic (e.g. wholly true, wholly false, wholly uncertain, partially false, partially uncertain, unknown or absurd), and infinite-valued logic (e.g. fuzzy logic), may be accommodated in the WOR paradigm, and open to non-monotonic elasticity. Exceptions to constancy are a destabilizing element in a conceptual system; they may also be a measure of the flexibility of a conceptual system. Monotonicity and values provide a form of continuity in moving around a system of conceptual relativity. They act as controls which stabilize meaning. The conceptual continuity of monotonic reasoning and of comprehensive or holistic values, in the metaphysical world of the human mind, replaces the time and space continuity of the real world. They are as essential to human intelligence as time and space continuities are essential to the human senses.

A generic knowledge engineering tool would allow the expertise from various domains to be considered jointly and severally as required. It is easy to understand how convenient it would be, in cases of personal injury, for a legal expert system to incorporate a medical expert system. Expert evidence could be available in legal expert systems. Some legal expert systems have been constructed using well-tried forms of inference engine. The suitability of available shells for legal knowledge and legal tasks has not been fully explored. However, it is clear that these systems could be better developed to suit the field of legal

knowledge engineering. Before these developments can occur, there needs to be extensive investigation of the structures of legal knowledge and the processes of legal reasoning, in order to model the computer processes and shell interfaces that would suit the legal domain. This thesis extends the investigation.

Two different tasks from the same domain may require different processes. Further, different processes may be required within the one task. Some shells contain a variety of tools in addition to inferencing processes. A shell might have a calculating device, a procedural process, or it may permit the processing of some algorithm or paradigm of ideas. A shell may be a versatile computer environment for producing intelligent services. There are clear indications that a TECLAW system requires more than an inference engine. Later in this chapter, the components for a TECLAW system are considered.

b. The Development of Artificial Intelligence

In his book, *Artificial Intelligence*, Patrick Henry Winston defines Artificial Intelligence as follows:

Artificial Intelligence is the study of ideas that enable computers to be intelligent.(15)

But, he says, intelligence defies definition.

But what is intelligence? Is it the ability to reason? Is it the ability to acquire and apply knowledge? Is it the ability to perceive and manipulate things in the physical world? Surely all of these abilities are part of what intelligence is, but they are not the whole of what can be said. A definition in the usual sense seems impossible because intelligence appears to be an amalgam of so many information-representation and information-processing talents.(16)

Artificial intelligence is currently studied in three areas: robotics, natural language simulation,, and expert systems. This thesis is concerned with expert systems and the aspects of intelligence that are relevant to legal expert systems. In Chapter Two, the view taken of intelligence was that it was evidenced by

thought paradigms, or thought systems, which could stabilize information and provide solutions to problems. These paradigms are useful in the design of artificial intelligence programs, especially in the tasks of information-representation and information-processing. They also point the way to other useful paradigms.

All computer processing is, in a sense, artificial intelligence. The earliest uses of computation were arithmetical, based on the predecessor of modern computers, the Turing Machine which was mathematically defined.(17) The inventor of the Turing machine, Alan Mathison Turing (1912-1954) helped design and construct computers at the National Physical Laboratory in Britain 1945-48 and subsequently continued this work at the University of Manchester. He developed early programming techniques and in 1950 published an article, Computing Machinery and Intelligence, in which he suggested that a computer could be programmed so that it would appear to have intelligence. An interest developed in the non-mathematical use of computers and computer scientists began to experiment with symbolic programs to solve problems.

During the second World War, cybernetics emerged as a field of study. In 1947, Norbert Wiener, the American mathematician, published his book, Cybernetics.(18) The term was derived from the Greek word, kubernetes, meaning pilot. Wiener defined cybernetics as 'the science of control and communication in the animal and the machine'. Ultimately, this became a very generalized science, comparable to General Systems Theory. In contemporary times, it is concerned largely with the study of effective organisation. With the influence of cybernetics, in the 1950's, researchers in artificial intelligence explored the possibility of building intelligent machinery by a simulation of the human brain. They designed neural network systems. One of the most notable of these was F. Rosenblatt's Perceptron, which simulated the human eye and recognized patterns.(19)

The field of artificial intelligence was established at Dartmouth College in Hanover, New Hampshire, in 1956, when a two month summer study of artificial intelligence was undertaken by a team of computer scientists. The team study was organized by John

McCarthy, who was then a young assistant professor of mathematics at Dartmouth College, and his friend from M.I.T., Marvin Minsky. The team included Allen Newell and Herbert Simon, from the Carnegie Institute of Technology (which later became the Carnegie-Mellon University). Shortly before the Dartmouth conference, Newell and Simon had developed the first list processing language, IPL (Information Processing Language) and used it to build a working A.I. program, the Logic Theorist, which was the first true artificial intelligence program. The program, Logic Theorist discovered a new and superior proof of a theorem; the Journal of Symbolic Logic refused to publish its work, on the grounds that if a machine did it, then it was not real mathematics.(20) Newell and Simon designed Logic Theorist on the basis of logic heuristics which they had worked out from an analysis of the rules of inference and how they are used.(21) By programming the machine to apply the rules of inference heuristically, they were able to control the combinatorial explosion which arises from considering all the alternative ways of applying the various rules of inference to logical premises. The practice of flowcharting the design of a program was established in 1947, in the construction of early computer systems,, by Herman A. Goldstein and John von Neumann.(22) Newell and Simon designed the Logic Theorist program by initially flowcharting their system of logic heuristics.

The Dartmouth group rejected the neural net model because they regarded the task of accurately modelling the complexity of human intelligence in this way as far too difficult. Instead they adopted a simpler and more realistic approach. They used digital patterns to automate the process of intelligent distinction between symbols which are the same and symbols which are different. This paradigm of categorization or sorting rests on the ancient Greek dialectic theory of Zeno. Their approach is described by Richard Forsyth as follows:

They viewed problem solving as a search through a space of potential solutions, guided by heuristic rules which helped direct the search to its destination.(23)

Artificial intelligence was regarded as a matter of matching input to information in the system which would then determine the output. Matching is the process of tying corresponding objects together. Newell and Simon explored the techniques that might be common to solving many different problems, and by 1957 produced, GPS (General Problem Solver).(24) John C. Shaw carried out the programming tasks for the systems designed by Newell and Simon. The search procedure of GPS is known as 'depth-first'; the problem is broken down, stage by stage, until there is a sub-problem which can be solved. Each piece of the initial breakdown is taken in turn and broken down as far as it can be. The breakdown of the first piece is not abandoned until it is established that it does or does not contain a solvable sub-problem. If it does not contain a solvable sub-problem, the system moves to the next piece and so on. Subsequent development of this form of search has produced more efficient search systems known as 'best first'. Depth may be abandoned in favour of breadth to make the search more efficient.

The high level language for processing numbers, FORTRAN (FORMula TRANslation), was introduced in 1957. Using this as a model, McCarthy formulated a list processing language, which one of his students, Steve Russell, further developed as LISP (LIST Processor). A list is a sequence of strings. At the end of each string there is a device which points to the location of the next string in the list. Lists can be modified easily because all that needs to be modified is the pointing mechanism. A list may be a member of another list. List membership may produce an Aristotelian hierarchy of genus and species of lists. Programs may process lists of symbolic data in intelligent ways. McCarthy established an A.I. group at Stanford University, where expert systems technology was subsequently developed.

In the early 1960's, the high level language, BASIC (Beginners All-purpose Symbolic Instruction Code) was developed at Dartmouth College to simplify the programming of extensive procedural tasks. This language accommodated linear and practical reasoning. Procedure might contain alternative paths in a decision process, and loops which allow an interim process or sub-routine, before continuing along a procedural mainstream. Loops on loops, or

nested loops could deal with a hierarchy of sub-routines. A BASIC program is constructed from the design of a flowchart of the procedural task. This led on to the representation of knowledge as trees and semantic nets, and the development of inference engines to process complex procedural choices.

The earliest expert system, DENDRAL, which carried out chemical analysis, was developed in 1965 at Stanford University by Edward Feigenbaum, Bruce Buchanan and Joshua Lederberg.(25) DENDRAL employs two rule-based sub-systems to carry out chemical analysis. The Feigenbaum team was concerned with finding a process which would solve everyday problems which experts dealt with, rather than the more formalized problems which GPS addressed. From the 'rules of thumb' in expert knowledge, they devised the processing of concepts in the rules to simulate the use of rules by the expert. They automated the expert's method or procedure, rather than the ontology underlying the method. In this way they could by-pass complex formal logic in the ontology and any truth problems in the validity of the ontology.

The study of artificial intelligence architecture progressed further with the earliest blackboard system, Hearsay-11. This system was developed at the Carnegie-Mellon University over a five year period from 1971 to 1976 as part of a DARPA (Defence Advanced Research Projects Agency) speech understanding project. The system was developed to understand the connected speech of a thousand word vocabulary. It employs several independent expert systems which cooperate through a global database called a blackboard. Following the completion of Hearsay-11, Lee Erman, who worked on the project, moved to the Information Science Institute (ISI) of the University of Southern California and produced Hearsay-111 which is a blackboard framework or shell containing no specialized knowledge about speech understanding.

In Britain, a report on the development of artificial intelligence was commissioned by the government. The report was produced, in 1972, by Professor Sir James Lighthill, Fellow of the Royal Society, for the Science Research Council. The report concluded that there was no future in AI research and it recommended that all funding should be terminated forthwith. Two reasons were

given for this view. Firstly, despite the success of DENDRAL, the task of controlling combinatorial explosions, which are inherent in the knowledge of a relative world, was thought to be insuperable. Secondly, it was thought that explanations which a machine could offer would necessarily be opaque; machine reasoning could never be explained as human reasoning. Machines could not deal with the depth, complexity, and soft edges of human understanding. The report included defences of the science of artificial intelligence by eminent professors such as Roger Needham. As a consequence of the Lighthill scepticism, the development of artificial intelligence in Britain was abandoned for a decade. It was during this period that crucial innovative work was undertaken in America and Japan. It is often a social phenomenon that conservative opinions are followed, and prove to be a hindrance to valuable discovery. Fortunately, the hindrance of unenlightened British politicians was confined to Britain.

In 1973, at the University of Marseilles, Alain Colmerauer and his associates developed the predicate calculus language, PROLOG. This language is based on a sub-set of predicate calculus, namely Horn's clauses. It established logic programming which was popularized with the publication of Robert Kowalski's book, Logic for Problem Solving, in 1979.(26) PROLOG was further developed at Edinburgh University. It implements logic by a backtracking mechanism which is limited in the extent to which it truly simulates all aspects of logical reasoning.

The proliferation of expert system projects began in 1975. The Stanford group entered the field of medical expertise with MYCIN, a rule-based system which provides diagnoses and recommends treatment for infectious blood diseases. Edward Shortliffe led the Mycin Project from 1975. In the course of construction of the program he undertook medical studies and qualified as a doctor. This was his solution to the difficulties of knowledge engineering medical expertise. The shell which was developed in the MYCIN Project, EMYCIN, became a prototype rule processor. It can chain through hundreds of rules, deal with probabilities and fuzzy logic, and explain its own reasoning by retracing its processing. The trace explains why a question has been asked and why a conclusion has been reached. The body of rules is known as the

knowledge base and these rules are a representation of the knowledge which is acquired from the expert by a knowledge engineer.

In 1978, the Japanese Ministry of International Trade and Industry gave the Electrical Laboratory the task of defining a project entitled, Fifth Generation, to develop computer systems for the 1990's. The project began in 1982, under the leadership of Hajime Karatsu. The objective of the project was to construct hardware and software which would make computers more familiar to ordinary people. In order to achieve this, a new architecture is under development, oriented toward comprehensive processing of knowledge. Its interface aims at the human level, allowing input of ordinary language, pictures, images, and so on. PROLOG was selected as the basis for developing the logic programming language for the system. The system is being constructed in modules and major Japanese computer companies are involved in the project.

In 1979, J.R. Quinlan of Stanford University devised a system by which a computer could construct its own knowledge from a database of examples. The system is based on a concept-learning algorithm which grows its own decision trees from the examples in the database. During the decade of the 1980's, machine learning systems were developed. Generally, these systems can process the rules of a knowledge base to automatically extend the knowledge. They find meta-rules as inferences from the rules stated in the knowledge base. Richard Forsyth of the North London Polytechnic, produced a system in 1981, called BEAGLE (Biological Evolutionary Algorithm Generating Logical Expressions). The system uses a Darwinian scheme, termed 'naturalistic selection' which creates and amends rules of classification. In 1982, Doug Lenat of Stanford University, produced a machine learning system, EURISKO, which uses a three-dimensional AND/OR logic gate to simplify the management of vast and complex knowledge. EURISKO is described by Forsyth as follows:

But the striking thing about EURISKO is that its description language (the notation in which it stores rules and concepts) is expressive enough to allow it a rudimentary

self-consciousness, in the form of 'meta-rules'. It is rather an introspective system, and spends a lot of time monitoring its own performance, recording its findings as rules that apply to itself.

One of its discoveries had an ironic twist. It noticed that human rules tended to be better than its own, so it came up with the heuristic:

IF a rule is machine made,
THEN delete it.

Luckily the first machine-generated rule that EURISKO erased was that one!(27)

EURISKO, which is written in LISP, is designed according to a unit paradigm. Every concept in the system, including the rules, is a 'unit', and each unit has a number of 'slots'. The analogy to a database system is that the units are records and the slots are fields. Slots may contain any kind of data, such as strings, numbers and functions. There is no limit on the number of slots which a unit may have and the number may be expanded or decreased during processing. This means that rules and meta-rules are treated in the same way. Slots may have subslots which in turn may have sub-subslots and so on. The data-structure of 'units' stabilizes the coadapted sets of structural components represented in the 'slots'.

In 1982, the Japanese invited a number of countries to send a team of scientists to Japan to discuss participation in the Fifth Generation Project. Britain sent a team headed by John Alvey of British Telecom. The only academic in the team was Roger Needham, of the Cambridge University Computer Laboratory. Most of the team members knew little of artificial intelligence. Nevertheless, they were impressed by the scale and cohesiveness of the Japanese project, and recognised that Britain would benefit from a similar program of collaborative research. The Alvey Report, which was published in August 1982, recommended government funding to support a program of collaborative research. Soon after, the Alvey Directorate was set up, headed by Brian Oakley, for a five year period, to promote collaboration. Government funding of three hundred and fifty million pounds was allotted to the Directorate in April 1983. Numerous Alvey projects and Alvey

Clubs were formed to bring government, industry and academia together. Europe and the U.S.A. responded to the Fifth Generation Project by setting up similar organisations: in Europe, in March 1984, an EEC organisation, ESPRIT (European Strategic Programme for Research in Information Technology), and in the U.S.A., in January 1983, a consortium of computer companies, MCC (Microelectronics and Computer Technology Corporation).(28) The way opened for AI research and development to gather momentum.

Legal Expert Systems

When the nature and operation of a computer is described, it sounds like a highly improbable invention. However, the level of detail and precision in the construction of the equipment is of such a high standard that these machines work reliably. The task in legal knowledge engineering is to match this standard so that the conceptual or symbolic world of law and legal advice is reliably represented through the physical machinery of the computer. Computers could advice people of their legal choices. Further they could provide the information by which people could evaluate their alternatives in order to make an informed selection as the basis of their behaviour. In the course of this advisory service, computers could also clarify the behavioural requirements which the choices entail. If this information were equally available to everyone, then an important social equality will have been established. Decision aids can improve the intelligent behaviour of people, and build a more intelligent society.

Expert knowledge is a matter of specialised intelligence. The automation of expertise is specialised artificial intelligence. Every expertise, including legal expertise, has its own forms of knowledge and reasoning, which employ paradigms of human intelligence. Expert systems have been defined in various ways. The definition adopted here is that of Richard Forsyth.

An expert system is a computer system that encapsulates specialist knowledge about a particular domain of expertise and is capable of making intelligent decisions within that domain.

...Expert systems have given rise to a set of

'knowledge engineering' methods constituting a new approach to the design of high-performance software systems. This new approach represents an evolutionary change with revolutionary consequences.(29)

A legal expert system is a computer service which is a substitute for the professional services of a lawyer. It automates forms of knowledge and reasoning which lawyers use or could use. The knowledge and reasoning which is simulated may be the law itself and/or the heuristics of legal practice. Legal meaning is programmed as the processing of legal data. Inevitably, it is necessary to find static and dynamic structures in the meaning of legal information which can be simulated by the static and dynamic digital entities of the electronic devices. There must be a parallel between the physical and the metaphysical, a computer metaphor. In the automation of legal expertise, the knowledge which is the static part of the expertise, and the processing which is the dynamic part, must be precisely formulated.

In order to build a legal expert system, a higher level of consciousness about the expertise is required. For this reason the new jurisprudence of legal knowledge engineering has emerged. Theories and analysis of legal data, reasoning, heuristics and expertise, are relevant in the design of intelligent computer storage and processing of legal data. The study of classifications of legal expert systems and the relationships between knowledge bases, processes and expertise, is also a major part of this new branch of computer jurisprudence. In the development to date of artificial legal intelligence, it is clear that the legal discipline has been an integral part of the new science. Whereas the older sciences took law as a major paradigm, artificial intelligence has taken rule as a major paradigm. A wide range of studies in artificial legal intelligence have been established. There is some indication of lines of development now emerging, but it would be premature to speak of a pattern in the evolution of legal expert systems.

The idea of computerization of the law was suggested by the American School of Jurimetrics which was instigated by lawyer, Lee Loevinger in 1949 with the publication of his article, Jurimetrics - The Next Step Forward, in the Minnesota Law Review.(30) This

was three years after the first electronic computer, ENIAC, was put into operation in 1946. The initial development of the computerization of law began in 1956, at the Health Law Centre of the University of Pittsburgh, Pennsylvania, under the direction of John F. Horty. The legal problem which initiated the development of legal information systems was simple and commonplace. It is explained by Jon Bing:

A legislative reform proposed to replace the phrase "retarded child" in the health law statutes and regulations with the somewhat more neutral phrase "exceptional child." This called for the identification of all locations in the statutes and regulations where the phrase occurred. Horty tried to solve the problem in a rather conventional way by hiring a number of students to scrutinise the texts. But after several attempts he concluded that the students were unable to examine the texts with sufficient care.

The radical measure adopted by Horty was to convert all the texts of the statutes and regulations into machine readable form, and then to design a computer program which would sort through the texts, identifying all the places where the word "child" (or any form of this word, like "children" or "child's") occurred in proximity to the word "retarded" (or any other form of this word). In this way Professor Horty solved his trivial, and quite common, problem with legislative texts. But more important, the first prototype of a text retrieval system was made.(31)

The success of Horty's work was followed by a proliferation of legal information retrieval projects in various countries and through international organisations. Details of these projects are explained in the Handbook of Legal Information Retrieval.(32)

In 1963, English lawyer, Colin Tapper of Oxford University, instigated a series of experiments with case law retrieval, using the All England Reports and a series of administrative decisions concerning worker's compensation claims. The experiments compared the results of computer search and manual search, and demonstrated some of the values and limitations of legal information retrieval.(33) It became apparent that the design of the retrieval system could improve performance.

In 1960, the Association of American Law Schools formed a Jurimetrics Committee with the broad interest of the relationship of law to science and technology. The Committee on Political Behavior of the Social Science Research Council in America, soon saw that jurimetrics was concerned with eliciting new political perspectives on the legal system. Accordingly they provided financial assistance to the Jurimetrics Committee to hold a conference. In 1963, the Jurimetrics Conference was held at Yale University and brought a new focus to jurisprudential science. Loevinger pointed out that jurisprudence was regarded as the science of law. However, he defined jurimetrics in contrast to jurisprudence.

Jurisprudence is concerned with such matters as the nature and sources of the law, the formal bases of law, the province and function of law, the ends of law and the analysis of general juristic concepts. Jurimetrics is concerned with such matters as the quantitative analysis of judicial behaviour, the application of communication and information theory to legal expression, the use of mathematical logic in law, the retrieval of legal data by electronic and mechanical means, and the formulation of a calculus of legal predictability. Jurisprudence is primarily an undertaking of rationalism; jurimetrics is an effort to utilize the methods of science in the field of law. The conclusions of jurisprudence are merely debateable; the conclusions of jurimetrics are testable. Jurisprudence cogitates essence and ends and values. Jurimetrics investigates methods of inquiry.(34)

Loevinger sought to satisfy the ideal stated by Justice Oliver W. Holmes in 1895 at a dinner of the Harvard Law School Association:

An ideal system of law should draw its postulates and its legislative justification from science.(35)

Jurimetrics, as defined by Loevinger, is a development of jurisprudence as legal science. In his Foreword to *Jurimetrics*, the book of articles, arising from the Conference, Hans W. Baade specified three main areas of jurimetric study: electronic data storage and retrieval; behavioural analysis of decisions; and the use of symbolic logic.(36) The three areas were unified by a common methodology, namely, 'the scientific investigation of legal

problems'. In a further publication, in 1965, *Communication Sciences and Law: Reflections from The Jurimetrics Conference*, discussion was divided into five major areas: modern logic, quantitative methods and decision theory, information processing technology, programmed instruction, and linguistics.(37) The term jurimetrics has not become a catholic label, probably because qualitative symbols still prevail over measurement as the major feature of the legal studies listed under jurimetrics. A more recent school of American jurisprudence, the Semiotics School, advocated by Roberta Kevelson of the Centre for Semiotic Research in Law, Government, and Economics at the Pennsylvania State University, marks the swing away from measurement to a new extreme in emphasis on qualitative symbols.(38) However, the jurimetrics movement did serve to sharpen and extend the scientific edge of law. Most of its fields have been subsumed in the field of computers and law.

The book, *Jurimetrics*, collected together various components of jurimetric studies. One of the articles, by Djangir A. Kerimov, Professor of Law at the Leningrad University, entitled *Cybernetics and Soviet Jurisprudence*, indicates the influence of Cybernetics in the development of the computerization of law in Russia. A Legal Section had been set up in the Scientific Council on Cybernetics of The USSR Academy of Sciences. The purpose of the Legal Section was to apply cybernetic means and methods to deal with problems in the Soviet judicial system. The work of the Legal Section included the development of a law information machine language. Kerimov makes the following observations:

Although all control processes are governed by common rules and have common traits (i.e., obtaining information, coding and processing, storing and transmitting), each process of control proceeds differently, depending on its specificity. This makes necessary a careful study of the specific nature of control, particularly in the sphere of public law, for the purpose of working out the most effective machine language, algorithms, and programming, as well as for developing a logical information machine for solving problems of public law.(39)

In regard to the use of computer aids in legal education, Kerimov offers the following guide:

In this connection, I must say that the American specialists' tendency toward teaching by programming in a utilitarian way is inadmissible as far as we are concerned because it materially limits the possibility of independent search, comparison of possible solutions, and decision. In brief, it restricts the creative effort of the students and the development of their capabilities. Study with the aid of machines will require far more general use of special cybernetic equipment as well as a far more "interesting," more "flexible" and more "elastic" program of study.(40)

The influence of cybernetics in communist countries at this time is also reflected in the publication in Prague in 1963 of Victor Knapp's work on Legal Cybernetics.(41)

In another article in the book, Jurimetrics, Layman E. Allen and Mary Ellen Caldwell, both of Yale Law School, sketched out the rule paradigm for computer processing. Like Kerimov, they conceived legal information processing as confined to the letter of the law, rather than an exercise in drafting legal advice, according to substantive meaning of the law, for various lay purposes. They were concerned with judicial decision-making, rather than the utilitarian perspectives required for legal decision-making in the daily lives of those who must behave according to law.

The article by Allen and Caldwell is entitled, Modern Logic and Judicial Decision Making: A Sketch of One View. It puts forward, with systems drawings, a thorough breakdown of the Choice process of judicial decision-making. A crucial part of the decision-making system is described in this way:

How a decision is precipitated by means of Deduction from the outputs of the Choice process will, perhaps, be clarified by the consideration of the subprocesses of the Choice process and the Determinations that are their outputs. The subprocesses are:

(1) Fact Determination

- (2) Rule Selection
- (3) Semantic Rule Interpretation
- (4) Syntactic Rule Interpretation

Their outputs are:

- (1) Conclusions about Facts Determined
- (2) Conclusions about Rules Selected
- (3) Conclusions about Semantic Interpretation of Rules
- (4) Conclusions about Syntactic Interpretation of Rules.(42)

The rules are interpreted according to the choice of semantic and syntactic interpretation. Further definition of this is given.

The rules themselves are in (or can be transformed without changing their meaning into) the form of an "if-then" statement which asserts:

If certain conditions are fulfilled,
Then certain legal consequences follow.

The Semantic Rule Interpretation process is concerned with relating (1) the facts determined to (2) the antecedent of the rule selected - that is, with deciding whether or not the events determined to have occurred fulfill the requisite conditions specified by the antecedent of the selected rule. In this process attention is focused intensively upon the individual words and phrases used in the antecedent of the rule and what it is appropriate to read them to mean. What the whole antecedent of the selected rule is interpreted to mean will influence the decision about whether the events determined to have occurred fulfilled the conditions specified in the antecedent, and the meaning given to the whole antecedent depends to a considerable extent upon the meaning given to its individual words and phrases.

Syntactic Rule Interpretation, on the other hand, is not concerned with the role of the meaning of individual words and phrases in determining the meaning of the antecedent of a rule; rather, it is concerned with the meaning of the overall rule and how its meaning is influenced by the relations intended between the individual words, phrases, and sentences within that rule. The syntax of the antecedent will determine which combinations of conditions need to be fulfilled in order to reach the consequent, and the syntax of the consequent will determine which combinations of legal consequences follow, that is, what is

forbidden, permitted, or required.(43)

The outputs of the Choice processes constitute the input of the judicial Deduction process. However, given that there are various forms of reasoning, there must be a Selection of a Logical System, before the input from the Choice processes can be formulated as the Deduction process. In order to automate deduction, rules must be normalized in a standard form and notational machinery must be developed. On this basis, Allen and Caldwell examine the if-then paradigm as a normalized form suited to automation. They explore the various flow diagrams which might represent different syntactical meaning in an if-then rule. These flow diagrams provide a chaining paradigm for the development of inference engines.

In the year prior to the Jurimetrics Conference, Allen's book, WFF 'N PROOF, The game of Modern Logic, had been published.(44) In this text, Allen converted propositional logic into a board game. The idea of logic as a game of signs (un jeu de Caracteres) had been mooted by Leibniz in the eighteenth century. Allen's work may provide a paradigm for designing legal games. He brought to the law, the formal structures of logic as a basis for semantic computation and founded a new approach to jurisprudential logic. At the Second Florence Conference on Logic, Informatics, Law, in 1985, Allen, together with Charles S. Saxon, presented a paper which explained a formal logic of Hohfeld's deontological study of the relationships between rights, powers, privileges, immunities, no, rights, duties, liabilities and disabilities.(45)

At the time of the Jurimetrics Conference, in 1963, the development of software for artificial intelligence programs was in its infancy. Due to the software limitations of the 1960's, computer jurists, conceived the computerization of law as data storage and retrieval, which might be developed into legal information storage and retrieval. They were more concerned with retrieving the relevant letter of the law than with automating the various applications of the meaning of the law.

In 1968, the United Kingdom Atomic Energy Authority sponsored a project to construct a legal information retrieval system, STATUS

(STATUTE Search), ostensibly for atomic energy legislation. The project was initiated by another English lawyer, Bryan Niblett. The development of STATUS continued the work of improving search programs. The paradigms developed in the search processes of information retrieval systems, provided a basis for more specific intelligent programs. Retrieval strategies usually employ Boolean logic to specify the concept sought. Boolean operators, such as AND (conjunction), OR (disjunction), and NOT (negation) are used to indicate the relations between several terms that identify the concept sought in the data. Fuzzy set theory may be used to refine the Boolean specification by placing different weights on different terms used to specify the concept sought. Further refinement can be achieved through iterative techniques, whereby the concept sought becomes more and more narrowly defined by the user until the pertinent material is identified for retrieval. Other techniques, including the use of positional operators, ranking, vectors, snowball functions, truncation, the synonyms of a Thesaurus, and mask functions, can further improve the performance of a system. The anatomy of text retrieval systems is well covered in the Handbook of Legal Information Retrieval.(46)

During the 1970's, legal information retrieval systems, which could operate large legal databases, were developed, and resources such as LEXIS and CLIRS became available to the legal profession. These database systems amount to little more than simple storage and retrieval of primary source law. Memory and recall may be essential to human intelligence, but these computer processes could not be described as artificial legal reasoning. The search systems of these large databases are not always effective. Hundreds of potentially relevant documents could be turned up for consideration. No assistance is given with understanding the meaning of the primary source law. Richard Susskind deals extensively with the limitations of these systems in his text, Expert Systems in Law.(47) In the 1980's these systems were seen to add to the problems of information explosion. The list of relevant authorities cited in legal argument grew as retrieval systems expanded. The volume of information to be reconciled theoretically increased greatly, protracting litigation and its cost.

With the expert system, DENDRAL (1965), the chemical analysis system, rule processing was simulated. Subsequently, in 1970, B.G. Buchanan, a computer scientist who was involved in the DENDRAL Project, and T.E. Headrick of the Stanford Law School published a joint paper, Some Speculation about Artificial Intelligence and Legal Reasoning.(48) The work on artificial legal intelligence trickled through the 1970's. In 1972, L.T. McCarty commenced work on his TAXMAN experiment.(49) TAXMAN is an aid for investigating legal arguments in the domain of corporate tax law. A LISP language, Micro Planner, was used in its construction. Legal concepts are represented in a logical framework which establishes the nature of the user's case. A transformation methodology then relates the user's case to similar cases so that arguments can be developed. McCarty's work developed from the morphological analysis of legal language which took place in the work of improving legal text retrieval systems. By the 1980's, McCarty's work had brought him to the task of developing a computer language for law. At this point artificial legal intelligence is closest to natural language work in artificial intelligence. In 1982, at the Colloquium on Data Processing and the Law, at Leicester in England, McCarty conceived a legal language as a deep conceptual model of the legal domain.

We are looking here for a language which is rich enough to express the important facts about a particular legal world and yet abstract enough to suppress the irrelevant detail. The purpose of our conceptual model, then, is to specify exactly which of these details should be expressed, and which should be suppressed, and how.(50)

At the Second International Conference on Artificial Intelligence and Law, in Vancouver, in 1989, McCarty put forward the following claim:

Clearly, if a language of this sort could be developed, it would provide a uniform framework for the construction of a legal analysis/planning/retrieval system, and a solid foundation for further theoretical work.(51)

At the second Florence Conference in 1985, McCarty had envisaged using an open dynamic logic as the basis of a legal programming

language. He suggested that there should be three levels of the language: level 1 defined on states; level 2 defined on sequences of states or worlds, and level three defined on sets of worlds. These three levels were chosen to stabilize his language as a system. He summarized the scheme as follows, indicating the importance of semantic primitives as the basis of design of semantic processing:

The basic idea here is to define a primitive action as a simple change in the state of the world, and then to build up more complex actions by various forms of compositions: disjunction, parallel composition, sequential composition, existential and universal qualification, and so on.(52)

The development of a computational legal language is likely to improve the tools for description and processing of legal choice, since legal expert systems are inherently choice instruments.

In Britain. in 1972, Ronald Stamper, Sandra Cook, and others in the LEGOL Project at the London School of Economics, set out to construct a LEGally Oriented Language to deal with the language and structures of primary source law, particularly legislation. They aimed at constructing a tool which could deal with any complex rule system involved in human decision-making. Their method was to experiment with the semantics of legal language, rule processing, and tree structures. They drew on the central ideas of relational databases which had been propounded by E.F. Codd in 1970.(53) Data elements were classified into three sorts: things, which are independent; conditions, which depend upon the data elements they relate to; and states, which last as long as the coexistence of data elements that give rise to the states. On this basis, each entity has attributes with specific values. The entity-attributes-values constitute a list or tuple paradigm. The tuples, in the form of rules, are assembled into relations for manipulation by the LEGOL operators. LEGOL amounts to a language for manipulating a relational database; for this purpose, it uses a deontic operator, duty or obligation. The LEGOL team found great difficulty in arriving at a deep model of legal knowledge, and could not provide an adequate means of linking rules together into larger structures. They found that the complex structure of

legal knowledge and its workings was like a parallel programming language. Rules could form and reform complex patterns of human relationships. They explored, by shallow analysis, small legislative areas such as Family Allowance entitlement. In particular, they noted the vicarious feature of legal choice: a legal selection by one person may affect another who has no control over the decision-making.(54)

LEGOL was developed further as NORMA, which Stamper described as a system based on 'a logic of social norms and individual affordances'.(55) Stamper took the paradigm of logic as a closed system consisting of empty symbols awaiting interpretation, and opened it up by using the semantic content of the symbols to direct the logical processing of the user's situation. His logic of social norms allows for combinations of any number of variables, including time variables, and provides semantic rules which dictate the computation of the values to be given to each variable; this allows the user's case to be categorized and determined deductively or analogously, by reference to the appropriate legal combinations.

The earliest legal expert system which was made available to the public was developed by the Inverclyde Welfare Benefits Project, 1974-5 conducted by David du Feu and Mike Adler of the University of Edinburgh. This Project began a year before the MYCIN Project. Despite the Lighthill Report, they received funding from the Scottish Office, the Inverclyde District Council and IBM, for one year. Their Project was probably seen as a proposal for construction of a useful computer program, rather than a development of artificial intelligence. They constructed a system of three programs, using the high level language, ANSI COBOL. The validation program checks the client instructions for certain inconsistencies, gaps and difficulties; the calculation program determines eligibility for benefits; finally, the output program produces a letter of advice to the client. The system was put into use and was made available to the public for a sixteen week period in 1975. Studies were made of its effectiveness. There was some indication that prolonged public access to the system would increase claims for benefits. The impact of the service probably amounted to a severe tech shock for the community of

administrators who were unable to follow through on further use and development of the service. Du Feu and Adler paved the way for legal expert systems, although their innovation was grossly undervalued and their talents subsequently underutilised.

In August 1975, at M.I.T., J.A. Meldman published his Ph.D. thesis, A Preliminary Study in Computer-aided Legal Analysis. He developed LEGAL ANALYSIS SYSTEM, a tort system, using PSL (Preliminary Study Language). The system assists in the analysis of facts, in cases of assault and battery, by reference to a semantic net. The user is advised of the legal consequences of the facts and given the legal reasoning which supports the conclusion together with the relevant primary and secondary authorities. The development of legal reasoning tools continued with JUDITH, a legal analysis aid suited to the German code, designed in 1975, by W.G. Popp and B. Schlink.

In the 1970's chaining tools were developed and in the 1980's a range of such tools became commercially available for rule logic processing. Commonly, forward or backward chaining was offered to simulate reasoning. The computational rule paradigm in chaining can be correlated with Horn clauses which were developed in modern logic.(56) Roy Rada explains the difference between backward and forward chaining very simply:

A very simple production-rule system has two rules: 'IF a THEN b' and 'IF b THEN c'. Given the fact a an algorithm can chain forward to b and then to c. If c is the solution, the algorithm halts. Conversely, in a backward chain a goal, such as c, is given, and the search goes backward to b and then a. If a is known to be true, then the backward search halts. The appropriateness of forward or backward chaining depends, of course, on the problem.(57)

Another view of chaining is set out in the Glossary of the text, Building Expert Systems, edited by Frederick Hayes-Roth, Donald A. Waterman and Douglas B. Lenat. Their definitions are as follows:

back-chaining. A control procedure that attempts to achieve goals recursively, first by enumerating antecedents that would be sufficient for goal attainment and second by

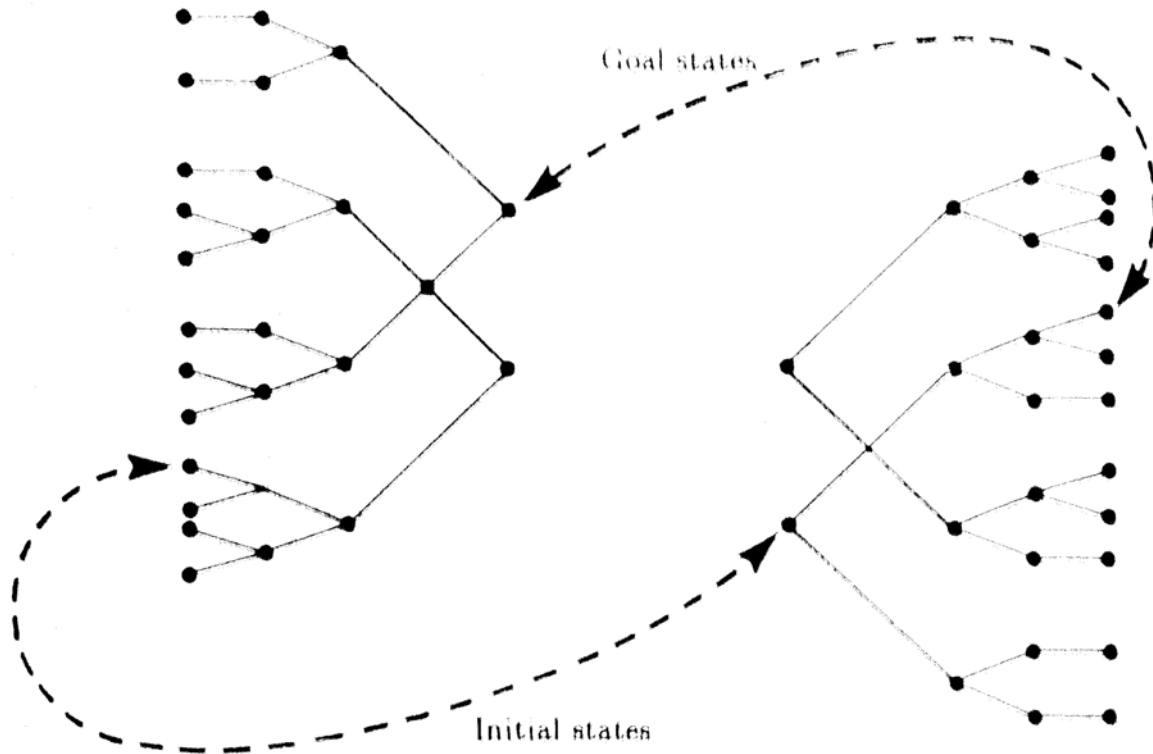
attempting to achieve or establish the antecedents themselves as goals.(58)

forward-chaining. A control procedure that produces new decisions recursively by affirming the consequent propositions associated within an inferential rule with antecedent conditions that are currently believed. As new affirmed propositions change the current set of beliefs, additional rules are applied recursively.(59)

Patrick Henry Winston illustrates the selection of backward and forward chaining diagrammatically. His explanation is set out in Figure 3.(60) The idea of reasoning backward and forward is a well established practice in logic. A.D. Ritchie in his book, Scientific Method, published in 1923, refers to the practice.

Logicians, of whom Mathematicians are a species, have started by considering the formal relations of familiar propositions which are considered to be true as a matter of fact, for instance, the propositions that two and two make four and that things which are equal to the same thing are equal to one another. These propositions are always asserted as describing relations believed to be true as a matter of fact, and to be in effect assertions of laws holding between the things of the external world. That some people have also said they were necessary or self-evident, or implied by the laws of thought is beside the point. From such starting points the logician has worked both backwards and forwards, forwards to find what other propositions can be inferred and backwards to the propositions from which they can be inferred. The reason for working backwards is to obtain a coherent system of propositions beginning with a finite number of axioms which are not capable of being inferred from anything else and which are taken as primitive. Definitions are further required in the course of the process, a definition, of course, is not a proposition as it is neither true nor false. It is an act of will and the logician has theoretically a free choice in definition, as he chooses to define his terms so his system of propositions will develop. Actually, of course, he is very largely restricted by the facts of the external world and the limitation of his imagination.(61)

Backward and forward chaining is also described by Richard Susskind in relation to the antecedents and consequences of legal rules which can be represented as an AND/OR tree or a goal tree; the description applies to a tree which is turned ninety degrees



The shape of the state space determines whether forward chaining or backward chaining is better. Fan-in situations call for forward chaining; fan-out situations, for backward. The wrong choice can commit the problem solver to chasing too many dead ends.

Figure 3 Winston's Trees

clockwise, so that the root node at the top of the tree is located at the far right.

In short, forward-chaining involves finding the antecedent of a rule on the left-hand side that is satisfied and then moving through the tree from left to right until a conclusion is reached, whereas backward-chaining entails starting at the conclusion on the right-hand side, as it were, and progressing leftwards in a search for antecedents that apply to the facts.(62)

Figure 3 represents the sort of tree described by Susskind. The nodes which feed into the root node are known as the children; children may in turn have their own children. Forward chaining is known as data-directed inference or antecedent reasoning, and backward chaining is known as goal-directed inference or consequent reasoning. Chaining entails a sequence of legal choices which either lead to the legal consequences of the facts selected or determine the facts which must be selected to achieve a certain legal consequence or goal.

There is also a process of sideways chaining, developed by Chris Naylor.(63) To achieve sideways chaining, rules are allotted different values, and each rule is allotted a different value at different stages of the processing. The questions which establish the evidence in the user's case, to test the applicability of a rule, are given the same value as the rule. Questions with the highest value at any time are asked first. Naylor describes the appearance of sideways chaining as follows:

Intuitively, the method seems reasonable, because the system simply asks questions which seem kind of important to it, continually modifying its ideas of what questions are important as the answers come in. This, it seems likely, is something like the way human experts behave.(64)

The development of heuristic expert systems, using rule processing systems, in the 1970's, opened the way to formal study of legal practice heuristics and legal relativity. Many small experimental legal expert systems and some prototype legal reasoning tools were developed throughout the 1980's.

From 1978, the Norwegian Research Centre for Computers and Law developed a program, SARA, which models legal norms in relation to decisions, so that new factors may be accommodated. The system was designed on the basis of different weighting of relevant factors and a calculation of the weights result. The user is advised of the weights of an argument.(65) This sort of system must be carefully designed to accommodate the hierarchical position of a new factor, as can be seen in the Australian system FINDER.

The earliest Australian projects are listed in Table A. In 1978, Philip Argy adapted the procedural language, BASIC, to the legal domain and constructed an in-house legal expert system, Trade Practices Problem Solving Programme. Argy, who is a partner in the international firm of Mallesons Stephen Jaques, produced his Trade Practices Problem solving program, PNA 003 (a typical legal office reference number comprising the solicitor's initials and file number), to improve the efficiency of the firm's legal practice. Because his areas of specialisation included Trade Practice problems, he was sometimes asked by other practitioners in the firm to advise in such matters; some matters could be dealt with readily, while others proved more difficult. In order to screen cases which did not require his personal attention, he provided his fellow practitioners with the facility of an advisory program. Being written in BASIC, the program takes the user through a step by step consideration of relevant factors in the decision-making process. The procedural flowchart amounts to a decision tree, and produces a conclusion about whether or not Argy should be consulted. The scope of the program is confined to Division 2A of Part V of the Trade Practices Act which was introduced by federal Act, No. 206 of 1978 and subsequently amended. The program was modified in 1983 to incorporate the amendments. Philip Argy has also constructed other legal office aids, namely, a stamp duty ready reckoner, scale cost ready reckoners, and a Foreign Investment Review Board decision-maker.

Roger Coldwell is a sociologist and an associate of the Department of Architecture and Building at the University of Melbourne. His program, CRIMSTRUCT, is being developed with a view to providing assistance to the police and legal practitioners in the

TABLE A

AUSTRALIAN LEGAL EXPERT SYSTEMS
(as at July, 1986)

Authors	Programs	Languages	Dates	Uses
1. Phillip N. Argy	PNA 003 (Trade Practices Problem Solving Programme)	Basic (Wang 2200 MVP extended Basic)	Commenced: 1978 Completed: 1979 Revised: 1983	Legal practice aid: provides advice on application of Division 2A of Part V of the Trade Practices Act 1974 (introduced by federal legislation Act No. 206 of 1978). Used as an 'in house' legal expert system of the legal firm, Stephen Jaques Stone James, Sydney.
2. Dr. Roger Caldwell	CRIMSTRUCT	Basic, (Enhancements in Basic; uses a CAD system)	Commenced: 1978 Incomplete	To reconstruct crimes (produces cartoon). Especially useful in police investigations.
3. Prof. John S. Gero & Dr. Michael Rosenman	BUILD	Prolog (has a specially developed expert system shell)	Commenced: 1984 Completed: 1985 Revised: 1986	To check compliance of buildings with the building code (uses part of the Australian Model Uniform Building Code). Designed for architects.
4. Graham Greenleaf & Phillip Griffith	COPYRITA (included in a package called DATALEX)	'C' (uses LES, a legal expert system shell)	Commenced: 1986 Incomplete	Operational for demonstration purposes; provides advice on statutory copyright protection in Australia.
5. Peter Johnson & David Head	BED (Benefit Eligibility Determiner)	Prolog (has a specially developed expert system shell, SSES DP - Social Security Enquiry System Development Package)	Commenced: 1984 Incomplete	To assist investigation of eligibility for Social Security pensions and benefits in Australia. Designed for Welfare Rights Centre.
6. Andrew Howbray & Rosalind Atherton	INTEST (included in a package called DATALEX)	'C' (uses LES, a legal expert system shell)	Commenced: 1985 Incomplete (Substantially complete and operational)	Provides advice and calculations for the distribution of an intestate estate in N.S.W. Produces a report (on entitlements and distribution) which can be saved.
7. Dr. Alan L. Tyree	FINDER (included in a package called DATALEX)	'C' (uses LES, a legal expert system shell - first working models in Basic, further developed in Pascal, current version in 'C')	Commenced: 1984 Completed: 1984	To demonstrate an experimental treatment of case law. Provides advice in the form of a legal opinion of user's entitlement to found chattels. The case most similar to the user's case is given and evaluated; from the cases which would have the opposite result the most similar case is also produced and distinguished as less similar.

investigation of criminal offences. The program permits the reconstruction of the activities whereby an offence occurred, in accordance with available testimony. Through computer aided design, the reconstructed events, in their environmental context, may be viewed as a cartoon. Furthermore, the cartoon can be run from any position in the environment. It is likely that conflicting testimony could be evaluated in this way and matters which might not otherwise be apparent may come to light. John Gero, the Professor of Architectural Science and Director of Research at the Architectural Computing Unit at the University of Sydney, has authored many publications on the subject of knowledge engineering. The program which he produced with Michael Rosenman, BUILD, was designed to assist architects to conform to building regulations. The system incorporates, as a rule-base, part of the Australian Model Uniform Building Code. Through the system, information about buildings and architectural drawings may be checked to see if there is compliance with the Building Code. Such an aid might also be useful to legal practitioners in the conduct of building disputes.

The Australian Social Security system, BED (Benefit Eligibility Determiner) formed the basis for the SSES (Social Security Enquiry System). The authors, Peter Johnson, a specialist in social security law, and David Mead, a knowledge engineer, have produced a legal expert advisor and aid, tailor-made for social welfare workers. The system was built for the Welfare Rights Centre in Canberra which was established by Peter Johnson. The Welfare Rights Centre became the Welfare and Legal Rights Centre (Canberra) Ltd. SSES provides advice on eligibility for Australian Social Security pensions and benefits; it is designed for use by social welfare workers as an aid in advising needy persons. The system carries out various advisory functions as well as drafting and engrossing appellate documentation.

SSES works largely through a series of menus and chunks of hard-coded advice. The menus divide the area of social security law into fields. A selection from a menu may lead into a rule-based module, another menu, or chunks of advice. Instructions are taken at certain stages of the program as a result of which rules are operated to determine which advice or

menu will be displayed. The instructions are also used to carry out the process of drafting documents. The advice given is extensive, thorough, and reflects a high level of expertise, both in legal reasoning and in the heuristics of legal practice. Processes are directed toward identifying the data which is to be retrieved as advice. A scheme such as this minimizes the amount of legal logic which has to be simulated by the computer and provides legal reasoning in the information which is retrieved. The breakdown of the domain into such a scheme permits the retrieval of appropriate explanations of law to suit particular problems. If the facility were further developed for use, not just by welfare workers but also by any lay users at welfare centres or public libraries, then advice could be obtained with complete privacy. The authors have now stripped the social security data from SSES and produced a shell called STATUTE which is commercially available. STATUTE is a knowledge base management system.

COYRITA, FINDER and INTEST are contained in a package called DATALEX. The DATALEX project was assisted by the Law Foundation of New South Wales, the Australian Research Grants Scheme, IBM Australia Ltd., the Centre for the Study of Law and Technology at the University of New South Wales, and the Computing Services Department of the University of New South Wales. Each of the three DATALEX systems provides legal advice after taking instructions from the user. COPYRITA provides advice on statutory copyright protection. It was constructed by incremental development of experimental versions. The difficulties of automating recursive legal reasoning or self-referencing jurisprudential systems are evident in the system. The authors, Graham Greenleaf and Phillip Griffith, designed the system on the basis of the legal categories in the federal copyright legislation; each category has a set of considerations. The categories are founded on a recursive definition, which is, essentially, that copyright is the right to protection of copyright. The legislation is dependent upon common law explication of copyright. The system reveals the difficulty of automating legislation without an interpretation of its common law context. The following initiation of the consultation in Version .5 indicates the drafting difficulties:

('Subject matter' means a form of expression e.g. a film, a TV broadcast, a novel, an LP record, a typographical layout, a song, a computer program etc.)

Please indicate in a word or phrase the subject matter of your problem:

film

The subject matter you have specified, film, is most probably protected under copyright as a 'cinematograph film'.

Do you agree ?

The intention of the authors here is not to ask the user to provide expertise, but to establish the statutory category of the item of property with which the user is concerned. Before drafting this sort of system, a preliminary empirical investigation might be made of all common types of items of copyright. The list of items could then be sorted into statutory categories, as the basis for identifying the relevant set of rules that applies to any item. Doubtful cases may be identified for special treatment. The user might be given access to the list of common types at the initiation of the consultation, after appropriate advice on the service offered by the system. If information is to be provided about the expert assumptions, then this should be done clearly, rather than by implication or by shifting the onus to the user who may not be able to make an informed decision. The empirical research which is required to identify the nature of legal choices, adds to the scientific dimensions of the science of legal choice. Ideally, a legal expert system should contain a feedback facility so that a user may send messages to the author about difficult cases. Then the system can be improved.

FINDER by Alan Tyree of the Sydney University Law Faculty provides advice as to whether or not the finder of a chattel, in the user's circumstances, is entitled to keep it. It produces a description

of precedent cases which indicates the basis of any rights to a lost chattel in the program user's case. Tyree is both a mathematician and a lawyer. The knowledge base consists of hardcoded information about several cases concerning trover. The system is designed to retrieve the closest precedent case to the user's situation in order to advise on the likely outcome of the user's case. Eight cases are incorporated in the knowledge base. The system could be described as a legal choice system in the realist school of jurisprudence. The advice is not always correct. However, the retrieval process is highly innovative and provides a paradigm which could be valuable. The system poses ten factors, which Tyree calls facts, to be considered in selecting the appropriate precedent. The factors are not a comprehensive list of possible material facts in a trover matter. However, they approximate some of the major considerations in an action in trover. For instance, one factor is as follows:

The other party is the true owner of the chattel or is claiming through the rights of the true owner.(66)

The factors are used to establish the attributes of each of the eight precedent cases. In an array each case is described as having or not having each of the ten attributes. The entry 0 indicates that the fact is not true and the entry 1 indicates that the fact is true. Prima facie, the major considerations are treated as having equal weight and there is no recognition of the hierarchical nature of the rules concerning each possible material fact. So, for instance, the overriding right of the true owner is not established. Rather, justice is worked through the Pythagorean theorem concerning right angle triangles in two dimensions. A nearest neighbour discriminant analysis is applied. The result is that if there is only one significant difference between a user's case and the nearest neighbour's case, then the user's case may be treated in the same way. This is so even if the distinguishing factor justifies, in law, a different result. People who are only marginally different mathematically, that is, in the number of their differences, are treated in the same way. However some difference in weighting of the factors is employed in the retrieval process. It is not a difference based on the different weightings in law. Rather it is based on litigation

variations in the population of the eight cases. An empirical, rather than a rule approach is adopted, which highlights the difference between the doctrine of precedent and the frequency of similarities in precedent cases. Finder is not regarded as a legal reasoning system, as noted by Anne von der Lieth Gardner.(67)

Each of the FINDER factors is assigned a different weight according to statistical calculations which produce a vector pattern. To achieve this, an average is made for each factor. The average is calculated by dividing the number of cases which have the attribute by the total number of cases. For instance, in only one of the eight cases, namely, *Moffatt v Kazana* [1969] 2 QB 152, the claimant is the true owner of the chattel. So the average for this factor is .125. Where an attribute is frequent, such as the attribute that the chattel was hidden or was in a position so as to be difficult to find, then the average is much higher; this occurred in six of the eight cases, giving an average of .75. The average is reduced to a variance by a formula which is applied to the average for each of the ten factors. A second formula is then applied, using the variance measure, where attributes of two cases differ, to calculate the distance between cases. This means that cases which differ on a low average factor have less of a difference than cases which differ on a high average factor. For instance, two cases which differ mainly on the point of the non-finder being the true owner, will have less of a difference than two cases which differ mainly on the point of the chattel being hidden or difficult to find. If a user's case lacks an attribute which most cases have, then the user's case and these' cases have a greater difference than the difference between the user's case, which lacks an attribute that only a small minority of cases have, and these minority cases. Such a basis for justice seems to introduce litigation norms to the notion of binding precedent. Precedents are less likely to be binding if they contain a majority litigation norm which does not apply to the user's case. In a sense, this protects the minority. Correspondingly, precedents are more likely to apply if they contain a litigation attribute which only a minority of cases have and which the user's case does not have. In a sense, this makes the minority dominant.

Ten questions are put to the user about the facts of the user's case. There may be either a negative or affirmative response to each question. As the user proceeds through the questions and gives responses, an array pattern of existent and non-existent attributes is established for the user's case. Calculations are then made, using the nearest neighbour discriminant analysis, to produce the nearest case to the user's, given the variations in the population of cases. Then a further selection process operates to select the next closest case which reaches the opposite conclusion. In three of the eight precedent cases in the knowledge base, the finder won; in the other five cases the finder lost. In law, the major considerations which support a finder's case may be some combination of existent and non-existent attributes. For instance, the absence of the attribute that the other party is the true owner, will support the finder's case, and so will the presence of the attribute that there was an attempt made to find the true owner. In each of the finder wins precedents, no more than three existent attributes are present, while in each of the finder loses cases, no less than four existent attributes are present. It could be that, in this system, if a user's case has less than four existent attributes, the finder is likely to win, and if the user's case has more than three existent attributes then the non-finder is likely to win, unless the different weighting of the attribute factors produces a variation on this. Since the weighting system is empirical, rather than jurisprudential, it may change an otherwise accurate result or fail to over-ride an inaccurate result. The processing which follows the questioning, usually takes less than a minute, and the user is then advised of the selected cases. Where the two relevant cases have a very similar degree of proximity to the user's case, the system will advise the user to seek advice from a human lawyer.

By commencing with a series of questions, to which the user must answer either 'yes' or 'no', the program establishes the attributes of the user's case. However, there are jurisprudential flaws in the user interface. For instance, one of the questions about the non-finder is as follows:

Is there any reason to believe that the non-

finder previously owned the chattel ?

A solicitor might ask this question, when interviewing a client, in order to establish if a line of questioning is appropriate. The answer 'yes', does not establish that the non-finder previously owned the chattel; nor does the answer 'no' establish that the non-finder was not the owner. Having a reason to believe something exists does not prove necessarily that it exists. In any event, the rule is that if the non-finder is contemporaneously the true owner, then the non-finder is entitled to the chattel, subject to any limitation of action. The question would be regarded as fishing if it were asked either by way of interrogatory, or without a proper context in a trial.

Another question may be difficult for a lay user to answer since the first part of the question might be answered differently to the second part:

Was there an attempt made to find the true owner of the chattel or is it clear that there was no such person ?

It is apparent from the user interface that the user perspective is assumed to be objective. The questions do not assume that the user is either the finder or the non-finder. A system should advise the user of the assumptions which the questions will make about the status of the user. Objective questioning requires the user to interpret the information according to the user's position. Some user's may find this difficult. Further, the drafting of the questions does not always correspond with the factors specified by Tyree. Attribute 6 is specified as follows:

One of the parties is relying on the terms of an agreement made with the other which purports to give him the right to the chattel.(68)

Whereas, the corresponding question put to the user is:

Does either party rely on the terms of a lease ?

In fact there are two cases where attribute 6 could be said to apply. One of these is *Armory v Delamarie* (1721) Strange 505, where the parties had either an evaluation agreement or bailment arrangement which might establish the attribute. However, the jurisprudential system is prepared on the basis of only two cases having attribute 6: *Corporation of London v Yorkwin* [1963] 1 WLR 982 and *Elwes v Brigg Gas* (1886) 33 Ch D 562. In both of these cases there was a lease of land. However, in *Corporation of London v Yorkwin*, the lease had an express term giving the lessor title to chattels found in the course of excavation work. This claim prevailed over the rights of the finder even though the finder was not a party to the lease; the finder was on the premises carrying out work for the lessee and found money in a safe which was buried underground. In *Elwes v Brigg Gas* the found object, a prehistoric boat, was lodged in the soil like a fixture; the non-finder was the owner of the land and therefore owned the content of the soil. The lease did not contain an express term giving title to the owner. The lease was relied upon in different ways in each case. However, money inside a safe, in the soil, could hardly be treated differently from the boat in the soil, so perhaps the express term is not a major factor to be considered unless a chattel were not attached to or buried in the property. Reliance by the court on the express term of the agreement, when the rule in *Elwes v Brigg* might have sufficed, is an indication that the court wished to expand the rights of the landowner who allowed entry on the land to a potential finder only under the terms of a contract. The courts sometimes extend the law when opportunities arise, even though existing law would have justified the same result.

Attribute 10 is as follows:

One of the parties knew of the existence of the chattel prior to the finding.

The question which addresses this factor is:

Did either of the parties know of the existence of the chattel prior to the finding ?

This attribute applies only in *Moffatt v Kazana*, where the non-finder, who was the owner, knew of the existence of the chattel prior to the finding. This is hardly a basis for the question which might give a finder's knowledge the same weight as an owner's knowledge. In the hard-coded advice, the facts of each retrieved precedent case are described and the similarities and differences to the user's case are stated, by reference to the ten attributes used in the system. Nothing in the advice reveals the empirical weighting system which is used and the nearest neighbour calculations. Sometimes, the advice includes traditional case analysis which seems disparate in the context of a legal realist system. For instance, in advice given about *Moffatt v Kazana*, as the nearest case, the facts of the case are stated. Then the following observations about the ratio are made:

The court held that the conveyance of the house and land did not suffice to convey the chattels in the house, a consequence of s.62 of the governing Law of Property Act 1965.

Consequently, the plaintiff remained the true owner of the tin of notes and was entitled to prevail.

Although the decision depends upon the provisions of a specific statute, it is clear that the true owners of chattels may displace the prima facie title of the owner of the land and the possessory title of any finder.

The system then continues with an explanation of the similarities and differences of the cases according to the ten factors. These features of the system raise new dimensions of the jurisprudential system of a legal expert system. For the retrieval process may constitute one part of the system and the retrieved data may constitute another part of the system with some partial or complete overlap in jurisprudential meaning of the parts. Retrieved data should explain the reasoning of the system of retrieval, especially if the processing device does not simulate an established form of legal reasoning. Lawyers are not generally acquainted with common statistical methods, and need a translation of the implications.

In most instances of use, the system will provide accurate advice. However, there are some cases where the advice given is incorrect. This is especially likely where the non-finder is the true owner, since the right of the true owner is paramount and cannot be given prima facie equal weight with other factors such as whether or not there was an attempt to find the true owner. The advice given, may or may not be consistent with the ownership rule. Two consultations which are examples of incorrect advice are as follows:

Was the finder of the chattel the occupier of the premises ? No

Was the chattel attached to the land ? No

Was the other party (the non-finder) the owner of the real estate ? No

Is there any reason to believe that the non-finder previously owned the chattel ? Yes

Did the finder hand over the chattel to the other claimant ? No

Does either party rely on the terms of a lease ? No

Is the finder a servant of the other party ? No

Was the chattel hidden or in a position so as to be difficult to find ? No

Was there an attempt made to find the true owner of the chattel or is it clear that there was no such person ? No

Did either of the parties have any prior knowledge of the existence of the chattel ? Yes

There are four differences between this case and *Bridges v Hawkesworth* (1851) 21 LJQB 75, namely that in this case, the non-finder is not the owner of the real estate; there is reason to believe that the non-finder owned the chattel; the ninth question, which is difficult to answer, is answered no instead of yes; and finally, one of the parties had prior knowledge of the existence of the chattel. The fact situation is that a customer in the shop whom the finder saw dropping the money, rather than the owner of the shop as in *Bridges v Hawkesworth*, is claiming against the finder. The system advises incorrectly that the finder should win, following *Armory v Delamarie* (1721) 1 Strange 505. If the non-finder, for some reason, had no prior knowledge of the money, the advice would also be that the finder should win; this might happen if a friend unbeknown to the non-finder, had slipped the money into the non-finder's pocket as a gift, perhaps with a note containing a suggestion to purchase something of benefit to the non-finder. None of the yes answers in this case apply in *Armory v Delamarie* which has yes answers only to the fifth and eighth questions. In *Armory's* case, a chimney sweep, who had found a jewel, gave it to a jeweller to value, and the jeweller refused to return it. This is not a precedent which could be used to argue the point in issue, unless, incidentally, it contained important dicta.

Inappropriate advice is also given, with less serious consequences, where all questions are answered 'yes'. Such a case might arise where the true owner of the money in the safe, who happens to work for the Corporation of London, and has prior knowledge of the money, claims it from the Corporation of London, the finder that displaced the entitlement of the workmen who unearthed the safe. The system advises, that the case is borderline but that the finder loses result is the more likely following *Corporation of London v Yorkwin*. *Hannah v Peel* [1945] 1 KB 509, is given as the contesting authority. In *Hannah v Peel*, a resident of temporary accommodation found a brooch and succeeded in recovering it from the owner of the real estate who was not the owner of the brooch.

Whether or not most precedent cases involve the issue of entitlement of the true owner, is an irrelevant consideration in a

claim by an owner. Quite often a point is firmly established in law once and never disputed again. Nevertheless, this point may be the most influential in determining human behaviour which is not the subject of litigation. Settled law is more suited to an automated service than unsettled law, since the advice can be given with greater certainty. The FINDER paradigm is jurisprudentially unsound if it represents an area of law, such as trover, where facts, or material facts, in law, are not given equal weight, and where the law determines hierarchical priorities by reference to a different judicial weighting of material facts. At the fringes of legal theory, where the rules run into evidentiary evaluation, relevant facts might be given equal weight, or they might be weighted unequally on the basis of expert opinion. In these areas, an adaptation of the FINDER paradigm might be valid. It might be possible to achieve an accurate representation of the hierarchy of rules, or facts, through appropriate weighting of factors; the geometrical nature of the rule or fact hierarchy could determine and justify the different weights.

The instruction path establishes the number of similarities and differences by which the computer system 'calculates' or identifies the corresponding cases by way of conclusion. The paradigm of similarity/difference, like the computer, is binary. The questions, alternative answers, and conclusions, in relation to each other, constitute the specific jurisprudential system which determines the validity or otherwise of the program. The processes of the program indicate the nature of the operations of artificial legal reasoning. Artificial legal intelligence consists of the jurisprudential system as it is operated.

Tyree's system does not provide advice which explains the minimum authorities necessary to support the user's case. The litigation average is no indication of the gradations of alternative attributes and their jurisprudential relativity. A thoroughly expert and precise system would be designed by reference to the range of claimants from the finders, and the range in other categories of attributes. Claimants range through: owner of found fixture; owner of found non-fixture; owner by contract; bailee; prior finder (an earlier finder); and post finder (a subsequent

finder). Each range may be regarded as a yardstick, or a list of alternatives. Some alternatives may be decisive; alternatives may be spread across the yardstick, according to their decisive value. For instance, if one of the parties is the owner of a found non-fixture the entitlement to which is contested, this factor is decisive for the parties: the owner is entitled, subject to any limitation of the action. At the other end of the yardstick, if one party is the bailee of the other party who is the finder, then this fact is decisive in favour of the finder, subject to any limitation of the action. The yardsticks or lists may be used to stabilize or measure the significance of each alternative in a list relative to each alternative in the other lists. Some groups of alternatives, one from each yardstick, will produce a finder entitlement, and some will produce a non-finder entitlement. The relevant precedents are those which establish the significance of all the yardstick alternatives which apply to the user's case. If there is no single case which deals with the same group of attributes as in the user's case, then it will be necessary to produce all the cases required to establish all the necessary points. Case-based reasoning selects the cases which make up all the attributes of the user's case. Rule-based reasoning selects from these cases, those cases which determine the significance of combinations of attributes in the user's case. The investigation of attributes must be thorough and complete before advice is given. Efficient investigation could be designed by reference to this sort of case-based and rule-based reasoning, and advice given on the selected cases. All that then remains is to discover the cases which contain some relevant obiter dicta. Cases with obiter may be matched to facts or rules which are established by precedent. Obiter which stands alone may be sketched into gaps in the law. Yardsticks may contain alternatives, and range positions, which are determined by obiter alone.

In FINDER, Tyree endeavoured to reduce legal theory to an empirical paradigm. The design of the jurisprudential system, ignores, firstly, the distinction between facts and material facts, and, secondly, the hierarchical structure of concepts and rules of law. Consequently, the system has no valid jurisprudential basis. Nevertheless, the FINDER experiment reveals a great deal about the mathematical structures in law. A

similar program might be devised in any area of case law. The process carried out by FINDER indicates how quickly artificial legal intelligence can work. FINDER demonstrates that an advisory task of a lawyer, which might entail hours of research, can be performed to a very high standard in a matter of a few minutes. Questioning to obtain instructions can be simple and efficient, and the advice which is produced can be more precise than might ordinarily be expected from a practitioner. A FINDER system could be developed further to provide advice on the alternatives available to prospective non-finders and finders to improve their claims to found items. For instance, contractual provisions might be made where possible, to protect the owner of property. Advice would depend upon the circumstances, but, generally, contractual protection is a method of securing interests and preventing disputes. Artificial legal intelligence can improve on human performance, especially if the system is a collaborative product of the best experts. Furthermore, artificial legal intelligence is immortal.

Like COYRITA, INTEST is concerned with legislation rather than case law. It, too, gives ex post facto advice rather than advice for planning to secure choices and decisions. Generally, litigation lawyers operate on the basis of advising on the consequences of something which has happened; commercial lawyers are more concerned with planning, but often use standard practices, rarely investigating and advising on legal choices in a proposed transaction or course of goal-directed behaviour. In order to formulate advice on choice, extensive legal research is required. Some empirical research also may be appropriate. The results of any empirical investigation must be synthesized with legal theory and primary source law. Jurisprudential systems for planning advice are not standard resources. Advice ex post facto could be based on a planning system. Certainly, in the development of an ex post facto advisory program, a choice structure is required to categorize a user's case, or to identify new cases and how they might be dealt with. A planning model, which may be founded on an element of empirical research, is useful in the design of ex post facto advisory systems; likewise, an ex post facto advisory system, might be useful in the design of a planning system.

INTEST was written by Andrew Mowbray when he was a student at the University of New South Wales. It has since been revised. In the course of building INTEST, Mowbray developed the DATALEX toolbox, LES (Legal Expert System), which has two original reasoning modules, a finite state machine, called DN (Decision Network generator), which can process decision trees, and Tyree's vector system, PANNDA (Precedent Analysis by Nearest Neighbour Discriminant Analysis). A generator is a program which writes other programs; generator facilities simplify the task of writing programs. Proposals for extending the toolbox to include a text retrieval system, AIRS, a production rule tool, an inductive decision tree generator, and tools to handle semantic networks and frames, are discussed by the Datalex team in a paper published in the 1987 Yearbook of Law Computers and Technology.(69)

The concept of semantic networks was developed by M. Ross Quillian, as a synthesis of neural nets and flowcharts.(70) Rather than simulating the physical brain, Quillian modelled the metaphysics of the mind through a model of meaning in language. Semantic networks usually represent objects, which might be any identifiable things, matters, circumstances or situations, and describe relations among them. All the information about an object may be dealt with in this way: the questions, what, who, how, when, where and why, may be asked about the object, and the answers may be cast in the constellation of a semantic net, a bit like the stars of an astrological sign. The object and the information about it are contained in nodes, and nodes are joined by links or arcs, sometimes called slots, which represent the relationship of the object and the information about it. Arcs are labelled according to the way in which nodes are related. These labels are useful in generating explanations, or designing the syntax of data structures. Semantic networks need not have a regular form like a goal tree. They may be used as an implementation framework for logic, and a basis for designing control strategies. Figure 4 is an example of a semantic network. Deontic nets might assist in modelling deontic logic.

In 1974, Marvin Minsky posed the schemata of frames in his seminal paper, A Framework for Representing Knowledge.(71) A frame is an index or list of factors, or table of information, about an

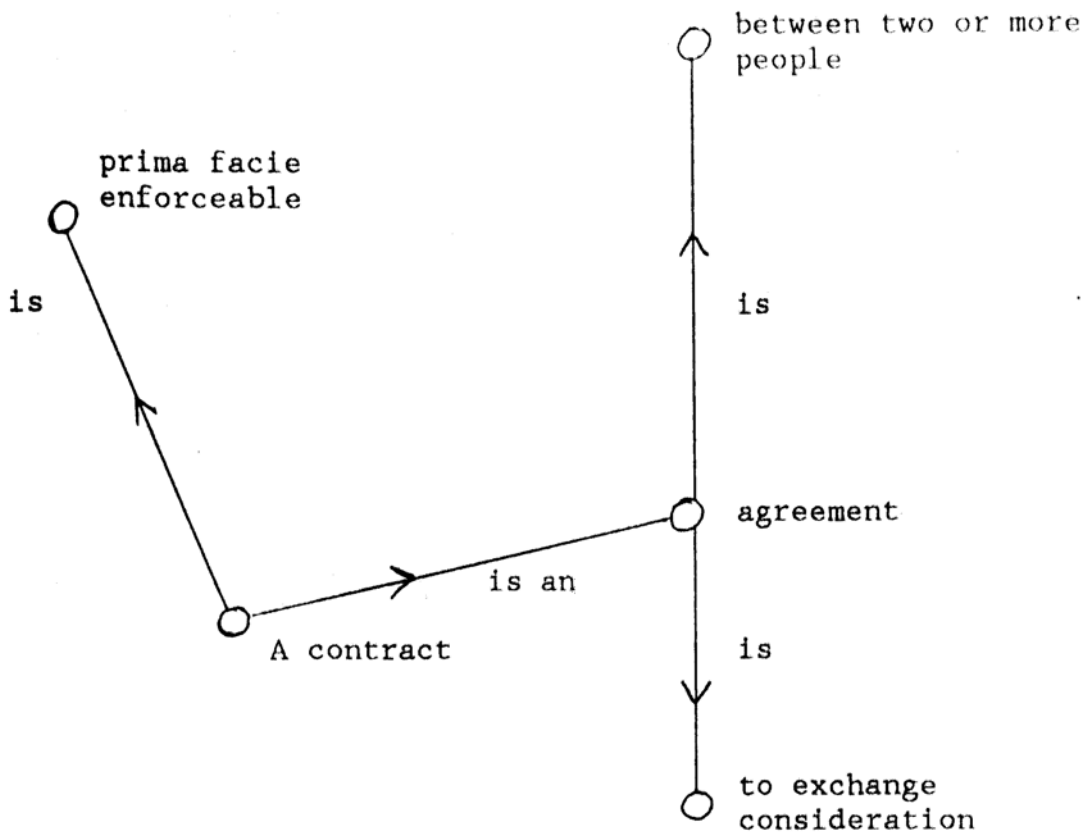


Figure 4 A Semantic Net

object, in the broadest sense. Each factor is expressed in both general and specific terms. For instance the frame of the contractual concept of consideration might contain the factor Timing and the detail that it must not be past. A frame represents a stereotype object, act or event and captures expectations about the object. It gives an object slots for significant factors about the object. These slots may be filled with default values. Frame information can be modelled as a semantic net or reformulated as a contingent paradigm (if...then) or rule. The arrangement of objects is the syntax of the representation; and the meaning in the objects and their arrangement is the semantics of the representation. Frames may also be linked in various systemic ways. A particular factor in one frame may be also a member of other frames. Things may be related by virtue of common components or factors. Further, they may be related in different ways. Various relationships may be stored as a relational database. The scheme of relationships between frames may take the structure of a tree. Frames may point to sub-frames which contain further detail. Frames are a basis of object-oriented high level languages.

In 1977 Roger C. Schank and Robert P. Abelson of Yale University, extended the paradigm of frames to transactions. They posed a transactional frame called a script, which listed the sequence of events in a stereotype transaction.(72) Transactions could then be related through common elements and various types of relationships. A plan may be set out as a script with a series of subscripts. In particular, they devised a system called PAM (Plan Applier Mechanism) which infers and evaluates the goals of people from their behaviour. They also developed a script understanding program, SAM (Script Applier Mechanism). At Yale, simultaneously with the development of PAM, Jaime Carbonell modelled several kinds of social, political and legal conflicts by using reasoning guided by a normative human goal tree. He also modelled personalities by reference to deviations from the normative goal hierarchy. In the normative hierarchy, he placed self-preservation and preservation of family members as the highest goals; preservation of property was placed next, followed by other lower goals or sub-goals. A deviant personality

described as ambitious, places the goal, acquire new property, higher than the norm.

Alternative stereotype transactions may be programmed as overlapping scripts. Legal choice might be viewed as a choice of scripts. Selection from alternative scripts may amount to a strategy and may deal with a sequence of alternative scripts ordered by reference to contingencies: if one script fails at some point of the transaction, change scripts to continue the transaction from the corresponding point in the second script. The addition of semantic net and frame processing to the LES toolbox would clearly extend the versatility of the system. The limits of a finite state machine greatly constrain the development of artificial legal intelligence systems.

Tyree defines finite state machine as follows:

A generalization of the tree structure is the "finite state machine". Such a machine is defined as follows: there are a number of different "states"; at each state, the user may be asked for information and the reply together with the value of other variables of the system determines the next state that the machine enters. The finite state machine generalizes the tree since loops and references to earlier states are permitted.

...Neither the tree model nor the finite state machine conforms entirely to the spirit of the expert system program as being a knowledge base which is entirely separate from the inference engine, since a great deal of the knowledge of the system is contained in the explicit interconnections between the states. These connections must be specified fully by the designer of the system at the time of writing the expert system. The system itself contains no means for the links to be established automatically or for the system to alter itself in any way.

...Neither tree models or finite state machines have been much used in the building of expert systems, probably because the programming required has generally been thought to be prohibitive.(73)

The generator in the DN module of LES has reduced the difficulty of machine state programming.

INTEST advises a user on the distribution of an intestate estate. As such, it emulates the task of an administrator in determining the beneficiaries and their respective entitlements. The value of the estate and family relationships are the major factors which the system processes, in accordance with the statutory provisions. The system follows the heuristics of legal practice, taking relevant instructions in an order which minimizes the number of questions put to the user. In the course of obtaining instructions, the system calculates the net value of the estate. It will also calculate, or advise on the apportionment of interests.

Essentially, the structure of the legal knowledge in INTEST is a tree. At some points in the branching, there are calculations carried out. If the user's input makes calculation impossible, information will then be put to the user so that the user can correct the instructions. For instance, if the given value of a mortgage owed by the intestate exceeds the total debts of the estate, a correction will be sought. INTEST produces a report of entitlements, complete with necessary mathematical calculations. Where a beneficiary, such as a spouse or a de facto spouse, is given a choice of entitlements, the system makes the calculations and provides information from which the user may evaluate the options and make an informed selection. The system demonstrates that professional tasks of a procedural nature, including calculations, may be structured as a decision tree and automated.

The DATALEX package, including the shell, LES, is described by Alan Tyree in his book, *Expert Systems in Law*.⁽⁷⁴⁾ The package is currently used for demonstration and teaching purposes; the systems are regarded as experimental. They make considerable inroads into the complex jurisprudential dimensions of artificial legal intelligence. Using the LES shell, students in the Computer and Law Interest Group at the University of Sydney have designed and built a program, Longarm, which provides advice on the range of circumstances in which service of process will be permitted by the Supreme Court of New South Wales, on a defendant outside of New South Wales. There are other student projects in some of the universities in Australia.

In addition to the in-house professional programs, and experimental academic programs, there are many Australian tax programs, some of which may be purchased, and some of which have approval from the Commissioner of Taxation. The Australian Taxation Office has published Instructions for Preparing Returns by Computer.(75)

In England, in 1983, the Alvey Directorate set up a legal project to run for five years. This was the DHSS (Department of Health and Social Security) Demonstrator Project that concluded in 1989. There was no lawyer in the DHSS Demonstrator Project. The members of the project team were drawn from the computer companies, ICL and Logica, the Universities of Surrey, Liverpool, Lancaster and Imperial College (London), and the Department of Health and Social Security. The project produced several prototype modules for automating the administrative and policy work of the Department. The modules were based on four jobs. Firstly, the job of advising claimants and assisting them to complete forms. Secondly the job of assessing claims for benefits. Thirdly, the job of policy formulation; the Department advises government and explains policy to members of the public. Fourthly, the job of legal knowledge engineering to maintain the computer aids.

The Claimant Information Systems contain an Advice System which allows the user to formulate and select questions within a predetermined range. It also provides policy explanations. The overall gist of these explanations is that the democratic majority, through the socio-political organisation, provides financial support for the satisfaction of needs of people, in certain circumstances where they would not otherwise be able to survive. The explanations acknowledge a social concern for the anomalous members of society who are without the means to survive. The language chosen aims for impartiality and has only the barest whiff of charitable condescension, of social disapproval of the beneficiaries, and of implied expectation that the beneficiaries will soon 'improve'. There is also the barest indication that the majority, whose social system prevails, is able to survive well enough to pay taxes sufficient to meet social security payments, and pays the social security benefits, as compensation, to those

who have a different social suitability but, as a minority, forgo the sort of social system in which they might survive well.

The legal knowledge engineering module is called KANT (Knowledge ANalysis Tool). It provides a window system which enables the user to move easily from legislative text to knowledge base worksheets and other aids, and then to the knowledge base itself. This facilitates cutting and pasting. There is a facility to establish links between particular parts of the knowledge base and particular parts of the primary source law. These links establish the authorities for the knowledge base and facilitate modification of the knowledge base if the law is changed. Links between parts of the knowledge base may also be established to accommodate inter-dependent matters. There is some structure provided for the analysis of the law, which rests on established tree structures for knowledge engineering of rule-based expertise. There is little assistance with jurisprudential analysis of the legal knowledge.

Five years after Argy had introduced legal experts systems to legal practice in Australia, The Oxford Project was set up, led by lawyer, Richard Susskind, and his friend, computer scientist, David Gold. It ran from 1983 to 1986. The Project was largely concerned with developing the jurisprudence of legal knowledge engineering. In order for the technology to advance, the jurisprudential analysis, that was required for the construction of legal expert systems, had to be developed. Stephen F. Smith put the problem in this way:

The construction of an expert system still remains pretty much of an art. While tools and methodologies have emerged to provide considerable aid in this activity, the process of eliciting, representing, and refining the knowledge utilized by the domain expert remains ill-defined and time consuming. (76)

This thesis is also concerned with contributing to the development of methods of jurisprudential analysis for automating legal advice. In particular, the thesis is concerned with the representation of static structures of legal choice and with the

dynamic processing of these structures. It is concerned to automate advice about legal choice, particularly for lay users.

One of the goals of the Oxford Project was to 'divine consensus in legal theory', as a basis for automation of legal expertise.(77) However, different views of legal theory may be automated; it is not essential to legal knowledge engineering that there be consensus about legal theory. Legal expert systems may be as various as the legal philosophies from which they are derived. The field of law selected by Susskind as the medium for finding a legal knowledge engineering paradigm which would suit all legal expert systems, was Scottish divorce law.

In the course of constructing a divorce expert system, Susskind settled on an AND/OR tree representation of the knowledge, a search strategy which employs menus as well as questions, and a knowledge base of rules of law. The system was designed to suit an expert user rather than a lay user.(78) Susskind was primarily concerned with providing a bridge between positivist analytical legal philosophies, especially the recent works of jurists such as R.M. Dworkin, J.M. Finnis, J.W. Harris, H.L.A. Hart, H. Kelsen and J. Raz., and legal knowledge engineering. Against this background, he fashioned some of the fundamental requirements of legal knowledge engineering methodology. He recognised that legal expert knowledge included not just the rules of law but rational extensions thereof and practice heuristics; furthermore, this expert knowledge had to be formalized so that it could be artificially processed. In 1987, Richard Susskind became the first employee legal knowledge engineer with a firm of accountants in London, Ernst & Whinney, a position which he held for about three years. During this time, he produced, with Phillip Capper, a legal expert system, Latent Damage Law (1988), using a rule-based commercial shell.(79) Latent Damage Law explains the Latent Damage Act 1986, and related common law.

Other legal expert systems have been produced in Britain in the 1980's, using rule-based commercial shells.(80) These include many small experimental systems produced by Robin Widdison at the Centre for Law and Computing at the University of Durham.

Widdison observed that a jurisprudential graphic which could model legal knowledge was like a train track system.(81)

Jurisprudential analysis was also extended by Donald A. Waterman in collaboration with Jody Paul and Mark Peterson. The analysis was done in the course of building two legal expert systems. In 1984, with Peterson, Waterman produced LDS (Legal Decision-making System), and in 1986, with Paul and Peterson, Waterman produced SAL. produced a system, SAL (System for Asbestos Litigation). Both systems provide advice on product liability. They were constructed using the Rand Corporation knowledge engineering language, ROSIE (Rule-Oriented System for Implementing Expertise). This language offers both procedural and rule processing. Rules can take many forms, to suit various sorts of advice, and sets of rules can be arranged as nested, recursive procedures, to suit various forms of reasoning. SAL contains some rules which specify complex conditions for the operation of their consequences. An explanation facility, XPL, was developed as a result of the jurisprudential analysis. XPL was imbedded in Rosie, to meet the requirements of SAL. It modulates explanations, and offers a range of different forms of explanation of the reasoning processes of the system. The user can find out why a question is being asked, the reason for a conclusion in general or specific terms, and the rule or set of rules relied upon. A high-level explanation of the set of rules can be obtained, as well as a tutorial elaboration of the concepts in the set of rules. The systems offer multiple windows and menus in the user interface.

The jurisprudential analysis was also concerned with identifying the different form of processing required for different professional tasks. In 1986, EPS (Estate Planning System) was developed by Waterman, Paul and D.A. Schlobohm, to explore another form of legal task. EPS takes instructions from the user and produces a plan which the user can either modify or approve. The approved plan is then used to generate the user's will. It has a tutorial facility to explain estate planning concepts and terminology.

At Stanford University, Anne von der Lieth Gardner also undertook a jurisprudential project. Her findings were published in 1987 in

her book, *An Artificial Intelligence Approach to Legal Reasoning*.(82) Gardner was concerned with developing a system which could deal with hard cases. She chose the domain of contract law and designed her system on the basis of a tree representation of a set of rules of contract law which might be used to solve a specified contract problem. The problem she poses is a law school test problem:

On July 1 Buyer sent the following telegram to Seller: "Have customers for salt and need carload immediately. Will you supply carload at \$2.40 per cwt?" Seller received the telegram the same day.

On July 12 Seller sent buyer the following telegram, which buyer received the same day: "Accept your offer carload of salt, immediate shipment, terms cash on delivery."

On July 13th Buyer sent by Air Mail its standard form "Purchase Order" to Seller. On the face of the form Buyer had written that it accepted "Sellers offer of July 12" and had written "One carload" and "\$2.40 per cwt." in the appropriate spaces for quantity and price. Among numerous printed provisions on the reverse of the form was the following: "Unless otherwise stated on the face hereof, payment on all purchase orders shall not be due until 30 days following delivery." There was no statement on the face of the form regarding time of payment.

Later on July 13 another party offered to sell Buyer a carload of salt for \$2.30 per cwt. Buyer immediately wired Seller: "Ignore purchase order made earlier today; your offer of July 12 rejected." This telegram was received by Seller on the same day (July 13). Seller received Buyer's purchase order in the mail the following day, (July 14).

Briefly analyze each of the items of correspondence in terms of its legal effect, and indicate what the result will be in Sellers action against Buyer for breach of contract.(83)

Gardner did not develop a user interface. Generally, suitably formulated questions to the user can establish an agreement between the user and the system about the facts, and to some extent, their interpretation. A legal expert system is limited in the extent that it can settle issues of fact. Law School problems are often presented in the fuzzy interface of law and facts so

that there is a confusion of questions of law and fact. This approach is very difficult for students; furthermore it does not properly train them in legal practice. The real test in this problem is to maintain clear cut rules and their application in the face of distracting evidence which tempts a student to doubt the clarity of the rules. The rules and their application are not really doubtful to a legal practitioner experienced in the natural practices of people which do not conform to the laws' categories. As long as all the relevant rules are carefully tested by reference to the facts, the solution is straightforward. Gardner formulated the step by step consideration of the categorization of facts so that the alternative sets of rules arising from alternative interpretations can be considered. She represented the alternative paths in an AND/OR tree. Each path amounts to an alternative possible legal scenario in the single fact situation of the problem. Her program operates at two levels, the easy case level and the hard case level. Where there are alternative interpretations, the system spots the issue, and advises on the results of each alternative path. The upper level of the program is a decision tree which contains the hard case choices. If the user's case contains an interpretation issue, then this will be determined at the hard case level. The system will then show the alternative interpretation paths. The lower level contains the detailed analysis of the alternative interpretations. In easy cases, no alternatives arise and information is given about the consequences of the user's case. The system is complex and treats the heuristics of legal reasoning with a great deal of sensitivity. The output of the program takes the form of two graphs which show the results of the legal analysis of the user's case. In her conclusions, Gardner observes that there is an element of choice in the construction of legal argument which qualifies the deterministic or mechanistic application of rules. If alternatives carry different consequences, then there must be a closer scrutiny of selection processes. A system must allow for links between rules at points which are separated by fine distinctions, so that fine distinctions may be considered. Gardner discusses what she calls the Choice Points in the knowledge. She indicates a direction for further research:

Reasoning about which would be the better

choice remains a major research area for the future.(84)

The Society for Computers and Law was founded in the United Kingdom in 1973 and provided a continuity in the development of the field. In 1984, Chris Arnold at Leicester Polytechnic's School of Law, instigated a series of Yearbooks of Law Computers and Technology.(85) A comprehensive coverage of the world's computer and law organisations, activities and journals, is set out in the Handbook of Legal Information Retrieval.(86) The development of artificial legal intelligence was promoted in Europe in the 1970's and 1980's largely through the work of computer and law centres such as the Norwegian Research Centre for Computers and Law, which was established in 1970, and through conferences,, such as the Florence Conference on Logic Informatics, Law, which was first held in 1981. Both the Florence Conference and the Norwegian Research Centre have produced major contributions to the development of a deontic logic as the basis for a high level language suited to artificial legal intelligence. The founder of deontic logic, Georg Henrik von Wright, at the first Florence Conference, posed the basic requirement of deontic logic, namely that it must be concerned with more than just truth and monotonic hierarchies. Deontic logic has been developed as the logic of norms and builds on the notion of normative systems. It also encompasses the logic of choice. Logical consistency and behavioural possibility are required in both descriptions and prescriptions of legal norms and their associated heuristics of legal practice and legal choice.(87)

It is likely that a free-will or opportunistic deontic logic would extend understanding of the rules of law and might clarify some aspects of legal choice. Consistency preserved by deontic logic must take account of behavioural possibility and consistency, as well as semantic consistency. Some juridical logicians recognise a requirement for deontic logic to incorporate a logic of action or behaviour.(88) Law is both prescriptive and descriptive.(89) Rules of law determine legal choice about behaviour or action including speech acts; even the choice of mental states which may accompany certain behaviour is both described and prescribed. Legal choice may expand or restrict natural choice. Usually, choice expands through an increase in rights, and is restricted by

an increase in duties. However, the expansions and restrictions are relative. An expansion of choice or opportunity for one person may carry restriction for that person in other ways. Between people, expansion for some may be restriction for others. Deontic logic may or may not assist in the analysis and processing of legal choice, depending on how it is developed. The same applies to other developments of formal logic: modular logic, qualificational logic and temporal logic.(90)

ESPRIT, which was set up by the European Economic Community in response to the Japanese Fifth Generation Project, was allotted 800,000 ECU's for the first five years. The first ESPRIT legal project, Foundations of Legal Reasoning, began in 1989, led by a British Company, Machine Intelligence Ltd. Academics from several universities in EC countries, including some British Universities, are members of the ESPRIT team. The author became the first non-EC member following collaborative work with Machine Intelligence Ltd. in 1989. ESPRIT plans to set up a second legal project, commencing in 1990, to construct a legal decision-making system.

The first judicial expert system has been in use in the United States of America since 1987. It was demonstrated at the Second International Conference on Artificial Intelligence and Law, Vancouver, in 1989. The system, JEDA (Judicial Expert Decisional Aide), was built by Charles P. Rippey, an administrative law judge with the U.S. Department of Labor in Washington DC, Vishwas P. Pethe, a professional software engineer, and L.V. Kale, a computer scientist, using high level computer languages, Turbo Prolog (1.1) and Turbo Pascal (3.0). It is designed for use in decision-making under the Federal Coal Miner Health and Safety Act 1969, as amended. Under this Act miners who suffer certain work-related lung disease, and their dependents, may claim benefits. The system has provision for organizing evidence, legal reasoning and modelling the judgment. The reasoning device takes the judge through the relevant considerations and allows the judge to make a finding in respect of each. Conflicts in evidence are also presented to the judge for determination. The judge has found that he can deal with cases much faster with the aid of JEDA. Consequently he now deals with significantly more cases. He has

indicated that he would be pleased if the lawyers who act in the cases before him were to use the system also, to further streamline proceedings.(91)

The most recent advances in the development of artificial legal intelligence have explored the use of blackboard systems. In CABARET, by Edwina L. Rissland and David B. Skalak of the University of Massachusetts, case-based reasoning and rule-based reasoning sub-systems interact through a blackboard.(92) A more complex system, PROLEXS, is being developed in Amsterdam by A. Oskamp, R.F. Walker,, J.A. Schricks and P.H. van den Berg of the Computer/Law Institute at the Vrije University of Amsterdam. This system separates rule-based reasoning and case-based reasoning but also further sub-systematizes rule-based reasoning so that there is interaction through the blackboard agenda between all the sub-systems of rule-based reasoning and the sub-system of case-based reasoning. The application of the system is in landlord and tenant law.(93)

The blackboard paradigm could be used to model a courtroom discourse. Several independent expert knowledge systems, being counsel and judiciary, might interact through a blackboard, the global system of a case. This raises the question of whether the law in action is one system or several related systems. Legal knowledge engineering requires an exploration of jurisprudential systems. It also delivers paradigms of human intelligence through which, to further explore and understand the law and its jurisprudential systems.

The CLIMS Project

The CLIMS (Contract Law Information Management System) Project commenced in 1985 as a vehicle of through which to develop for this thesis jurisprudential systems science and the science of legal choice in the field of legal knowledge engineering. The objectives of the CLIMS Project are, firstly, to build a comprehensive contract law information management system for business; secondly, in the course of doing this, to explore and construct a computer environment suitable for legal knowledge engineering; and thirdly, in the course of this work, to formulate

as far as possible, a legal knowledge engineering methodology. This opened up three fields of legal choice: legal choice in business planning; legal choice as computer processing; and legal choice in legal knowledge engineering methodology.

The inter-related development of a major contract expert system, a TECLAW (Total Environment for Computerization of Law) package, and a legal knowledge engineering methodology, began with research in potentially relevant fields: computer science, jurisprudence, philosophy, psychology, systems science and scientific methodology. The major conclusions from this research were, firstly, that specific jurisprudential systems would be required for the automation of law; and secondly that a theory of legal choice was needed to design these systems. Thereafter, under the umbrella of the Project, three experiments were conducted and exploratory work for further experiments was carried out. The three experiments produced, respectively, CLIMS Pilot (1987), CLIMS Pilot No.2 (1989), and 42 CLIMS Database Systems (1989). The first experiment was concerned with the nature of a legal knowledge base as a jurisprudential system. The second experiment was concerned with the development of a processing device, a system of inference engines that would process legal choice and provide a choice of processes. The third experiment was concerned with the relationship between legal choice in the jurisprudential system of a database and legal choice in the jurisprudential system of a knowledge base.

a. The CLIMS Pilot Experiment

i. Introduction

The first CLIMS Pilot was built at Mitchell College, now Charles Sturt University - Mitchell, in the town of Bathurst, New South Wales, by the author and Carl Jackson, a final year data processing student. A copy of the first CLIMS Pilot is kept in the envelope at the back of this book. The knowledge base is set out in Appendix A. Instructions for using the first CLIMS Pilot are set out in Appendix B. The aim of the experiment was to formulate an operable jurisprudential system with the objective of demonstrating the validity of the hypothesis that the rules of law

could be automated. A selection of law was taken from the settled areas of contract law governing the formation of a contract. Since law is readily expressed in terms of rules, rule-based systems were seen as generally suitable. A shareware shell which processes rules, ESIE (Expert System Inference Engine), was used. ESIE is a simple backward chaining device which processes a production rule system. Although ESIE is a simple shell, the legal knowledge engineering method used in the experiment, provides a basis for method in using a fully developed TECLAW system.

ESIE, is written in a high level language, PASCAL and runs on any MS/PC DOS computer, with colour or monochrome monitor, of at least 128 KB of RAM. If a colour monitor is used, then ESIE's colour system will produce, against a blue background, a top level in white, questions in light cyan, responses in light magenta, invalid responses and knowledge base errors in light red, trace functions and final conclusions in yellow. Information about the use of colours may be regarded as banal by most artificial intelligence scientists. However, this colour scheme provides some indication of the structure required for the jurisprudential system which the shell will process. Colour schemes could also be extremely useful in the development of a graphics interface which would assist a legal knowledge engineer to construct a system. Graphic interfaces are available in knowledge engineering tools such as Procedural Consultant and S.1, which are commercially available.(94) They considerably simplify the task of constructing a legal expert system. A program ought to be able to produce the data structures and implement the operators it requires from graphic-based instructions.

In the course of the experiment, a sample of rules of contract law was converted to an ESIE knowledge base. The nature of the inference engine and the syntax of the shell's system, proved suitable for legal knowledge. In the construction of the knowledge base, a streamlining of judicial dicta, text information and available practice heuristics, was required. To achieve this, the development of some jurisprudential methodology was necessary. The rules had to be mapped according to a suitable graphic, and then formulated as data structures, pursuant to the syntax of the

ESIE system. Some contraposition of the rules of law was required in this streamlining process to deal with the knotting of positive, negative, affirmative, disaffirmative, and uncertainty elements in the knowledge. The methodology had to suit both the shell and the knowledge.

A rule-based system provides an opportunity to represent the law in a computational form which permits semantic processing. The knowledge base must contain the constant static form of the law and the inference engine operates as the dynamic processing of the knowledge base rules for any given situation. The method of processing has a regularity which depends upon regularity in the knowledge base, and, accordingly, has a dynamic constancy. The CLIMS Pilot is an example of legal knowledge and reasoning as each remains constant in changing circumstances and as each is applied to different situations. When the CLIMS Pilot is operated, through the user interface, the result is legal information retrieval appropriate to the user's case.

In the ESIE backward chaining system, the inference engine puts questions to the user and receives the user's responses as input. Processing of the input amounts to searching through the rules to determine the next link in the chain of reasoning, and thus, the next question to be put until, ultimately, a conclusion is reached. There are alternative routes through the rules and the user's choice of input determines the selection of a legal reasoning path which leads to the legal conclusion or consequence which is appropriate to the user's case. The user interface works like a game of charades or a litigation interview of a client by a solicitor. The solicitor first establishes what the client wants, and then begins to ask questions to establish entitlements. The questions are determined by the rules of law which become relevant as the client's case unfolds. The client is not advised of the details of the legal choice field into which the client's case falls. This would be very time consuming; in any event, without a theory of legal choice, practitioners would find this a difficult advisory task. The client is usually advised ex post facto, of the legal significance of the client's case. Solicitors are rarely brought into a business as consultants to streamline the activities of the business according to the most advantageous

legal position. Business managers usually adhere to the view that their own worldliness should dictate how they optimize the business activities which are subject to legal intervention. Some business managers may have found that lawyers are not responsive to this advisory task anyway. Most conduct their businesses according to established, safe practices which may not be the best and may continue to sustain legal difficulties unnecessarily.

The method used in the first CLIMS Pilot experiment can be summarized as follows:

- . initially the hypothesis of the experiment was established;
- . then the sample of law to be automated and the software to be used was selected;
- . next, the general aim and objective of the experiment were determined;
- . an extensive analysis was then carried out of the limitations of the shell and, given these limitations, the way in which the legal knowledge could be represented;
- . on the foregoing basis, a jurisprudential analysis and systematization of the sample of law was undertaken and the knowledge base was prepared. In the course of this task, the river paradigm was found to be a suitable knowledge representation and design aid;
- . after completion of the Pilot, some testing, evaluation, and revision followed;
- . the results of the experiment permitted some formulation of the requirements for further experimentation, in particular, the developments required for a Teclaw system.

ii. Limitations of the Shell

Before the knowledge base was constructed, the limitations of ESIE were determined. As the limitations were examined, the framework for the knowledge base was formulated. The observations made in examining the shell and designing the representation of knowledge accordingly, may assist in the development of other production rule systems, and might provide paradigms of jurisprudential systems analysis which have a wider use, particularly in the design of other systems which are not production rule systems. It may be the case that contract law, or any area of law for that matter, has a form of knowledge structure which is a suitable basis for designing various types of systems. Significant limitations of the ESIE shell, and consequent system design, were as follows:

(1) Only backward-chaining was available. The information retrieval process is directed by the search for a goal. Forward-chaining, which would permit the retrieval of information about goals and steps along the way to any goal, was not available. Consequently, it was appropriate to build a system which advises, ex post facto, on the basis of an actual or hypothetical contractual transaction, rather than a planning system that would advise on the steps required to secure some nominated contractual benefit, and alternative paths which should be avoided. An ex post facto system still requires a specification of the legal choice field in the knowledge base. A limited planning system could have been designed so that a user would be advised as soon as there is a departure from the path that leads to a predetermined goal. However, processing would cease at the point of departure, and the user would have to start again to obtain further information. The correct path would be learned by trial and error, rather than efficient advisory processes.

(2) The form of the knowledge base is limited in these ways:

. Capacity

Only 400 "if" rule lines can be processed. Such lines begin at

"if", "and", and "then". Only 100 questions can be processed. Therefore, the jurisprudential system was limited initially to a sample of contract law, until it could be ascertained how many system rules of contract law there were, given the requirements of the syntax and chaining links. The sample was limited to the law concerning the formation of a contract, the first stage of a contractual transaction.

. Goal

Only one goal may be used. This limits the scope and purpose of the system. A goal was selected by reference to the overall norm objective in the first stage of a contractual transaction, namely, a knowledge of whether or not contractual rights and duties have been established in the contractual negotiations. There are three alternative forms of this knowledge: either a contract exists, or, a contract does not exist, or, there would be uncertainty about whether or not a contract did exist. The system might provide advice on contract status accordingly. The goal adopted was contract status which could be one of three variables:

- NO.INVALIDITY.FOUND
- RISK.OF.INVALIDITY
- INVALID

These variables provided the basic structure of the system: positive, uncertain and negative conclusions could be reached by various pathways or chains through a system of rules. The rules are the choice paths to the various conclusions. For each conclusion there might be several different pathways of antecedents and conditions. The variable, 'NO.INVALIDITY.FOUND' is the consequence of the antecedents and conditions which are chosen from positive rules of law; these positive choices produce the positive result. The variable 'NO.INVALIDITY.FOUND', is the consequence of the rules of uncertainty or uncertainty choices and is the uncertain result. Finally, the variable, 'INVALID', follows from the negative rules of law or the negative choices and is the negative result. The positive result is expressed in

negative terms, 'NO.INVALIDITY.FOUND', rather than positive terms such as 'valid', because it was assumed that the system capacity would be inadequate to process all the relevant rules. The rules in the knowledge base are formulated from some of the rules which apply to the negotiation of a contract.

The system is jurisprudentially incomplete insofar as it contains only a sample of the rule population or a sample of the choice field. Not all the rules or choices which determine validity and invalidity, were included in the sample. A complete knowledge base would contain all the rules or choices prescribing both elements which must be present, and also elements which must not be present, for validity. Contractual status can not be said to be valid until all these rules or possible choices are tested. Even then, the system may give a cautious conclusion, due to other uncertainties.

Where there is no rule that makes a particular contract invalid, there is always a possibility that, in the circumstances of a case, a court might make a new rule or choice to the effect that the contract is invalid. This new rule or choice may or may not overturn an existing rule or choice. Furthermore, the rule or choice population itself might be incomplete, in that it might not cover all possible cases which might occur in the jurisdiction, whether or not they are litigated. In these circumstances there must be provision for uncertainties about the stability and completeness of categories of alternatives and their consequences. Because of these elements of uncertainty in the positive result the more prudent advice might be, 'NO.INVALIDITY.FOUND'. However, the same view might be taken of the negative result. Prudence is relative to the position and aims of the user. User specification of the system required is of fundamental importance in the design of a legal expert system.

An ESIE system, to some extent, may take into account uncertainties in a user's case due to, firstly, the logical incompleteness of the domain rules or choices and, secondly, evidentiary uncertainties. Logical incompleteness of the rules of law or legal choices may be reduced by a form of contraposition and logical elaboration. This simply means that the

jurisprudential system is not logically complete unless it contains the propositions of all three logical dimensions. For instance, concerning revocation of an offer all three of the the following jurisprudential propositions must be stated as data structures: if there is revocation of an offer, then there is an invalidity; if there is no revocation of an offer, then there is no invalidity found on this point; and if there is uncertainty about whether or not there was revocation of an offer, then there is a risk of invalidity. The logic may be completed by necessary contraposition of expressly stated rules or choices so that there is a corresponding set of rules or choices for each of the positive, negative, and uncertain results.

To some extent ESIE requires that the logic be completed by the knowledge engineer, in the formulation of the knowledge base even if it has not been expressly completed in stated law; ESIE does not permit uncertainty in the completeness of rules or choices. The inference engine will not make assumptions and may fail to process a case if the logic is not fully stated: a failure in the logic is a missing link in the chaining process or series of choices, so that processing may break down. Rules or choices about invalidity are a form of contraposition of the rules or choices about validity. In the CLIMS Pilot, legal or deontic contraposition has two forms, the opposite and the uncertain. Uncertainties about the positive and negative results constitute a third set of rules or choices. All three sets of rules or sets of choices, positive, negative and uncertain, must be set out with appropriate correspondence of terms.

It may also be necessary to extend rules or choices by logical inference, and to expressly state assumptions which rules of law make. Behavioural choices must be stated clearly by an expert adviser; otherwise they are ineffective. Expert advice can not be vague. It must explain specifically any uncertainties in the rules and how rules might be stretched or contracted to resolve a conflict regarding priorities of behavioural choices. A rule in the knowledge base consists of antecedents and consequences. Sometimes, in addition to antecedents, there are conditions for the application of the rule; these appear very similar to antecedents. The rejection of an antecedent in one rule produces

a condition for the application of another rule. The following rule contains both conditions and antecedents:

```
if communication is do.not.know.  
and wholly.written is no  
and partly.written is yes  
and delivered is yes  
and comprehend.writing is yes  
and partly.oral is yes  
and comprehend oral is yes  
and partly.conduct is yes  
and comprehend.conduct is yes  
then offercom is ok
```

The first two lines in this rule contain the two conditions for the application of the rule. They are part of the chaining process. The next seven lines are seven antecedents and the last line is the consequence. The rule means that if the user is uncertain about whether or not an offer has been communicated and is certain that there is no offer wholly in writing, then, if no intervening rule is satisfied either, the user must indicate if a multi-form of offer has been chosen. The next choice path is the selection of an offer which is partly written, partly oral and partly negotiated by conduct. The written part must be delivered, and the offeree must have had the opportunity and capability to understand the written part; also, the the oral and conduct parts must be comprehended by the offeree. The questions which are put to the user to establish the antecedents, give the user a choice of accepting or rejecting each antecedent. The alternative of a partly written, partly oral and partly conduct offer, is chosen if all the antecedents are chosen. Then, as a consequence, the communication of an offer is chosen. The selection of antecedents entails the selection of their consequences.

It should be noted that choice theory in legal knowledge engineering does not require free will or conscious selection on the part of the user in regard to each of the antecedents which apply to the user's case. Sometimes the user will be responsible for the existence of facts which antecedents describe, sometimes another party will be responsible for their existence, and

sometimes the processes of natural selection will have created the real situation which the antecedents describe. There is a synthesis of human and natural selection in the real situation which the expert system is processing. If the user's case is hypothetical then there is a mixture of human and natural selection in the facts of the hypothetical case. If the expert system were a planning adviser, then it would advise on human and natural selection possibilities, and how each may be controlled through legal choices.

To stretch the rules is to add to them further antecedents or conditions for their application. This may widen or restrict the scope of application of the rule. To contract the rules is to reduce the antecedents or conditions. Again this may widen or restrict the scope of application of the rule. Sometimes an antecedent or condition may be expanded or contracted by, respectively, the inclusion or exclusion of matters within its scope. This is particularly likely if an antecedent or condition is open-textured, that is, a general or abstract term which does not clearly indicate all its particulars. The term, open-textured, was posed by Friedrich Waismann in 1945 and subsequently embraced in the jurisprudence of H.L.A. Hart and in contemporary legal knowledge engineering theory.(95) Consequences may also be modified or changed. The rules indicate choices of antecedents and consequences, and maintain their consistency. The choices are sometimes vague so that inconsistencies which are not yet apparent can be determined when necessary. These limitations are necessary in a legal system which does not conduct research into legal choice beyond immediate requirements. However, clarities and vaguaries in legal choice must be identified and clearly stated in a legal expert system.

In consulting an advisory system, the user may be uncertain of the evidence, or unable to say whether or not something exists or existed. ESIE can accommodate evidentiary uncertainty, by channelling the user to a 'RISK.OF.INVALIDITY' conclusion. However, the rules about this 'excluded middle', the cases of 'RISK.OF.INVALIDITY', must be clearly set out, corresponding to the positive and negative rules. These are heuristic rules, since a primary source statement of law does not provide for uncertain consequences.

The stability and completeness of the rules of law are subject to the realities of the doctrine of precedent. Specific jurisprudential systems may be designed by reference to the likelihood of a rule being overturned. Where rules are stated in high levels of abstraction and generalization, they may be qualified in later cases where more precise rules are formulated. In these circumstances, the high level rule is not overturned; it is merely qualified or particularized. It is sometimes said that it is harder to persuade a court to overturn a high level rule than it is to persuade a court to qualify it. Next, it is easier to persuade a court to modify a specific rule, than to persuade a court to overturn it. Only in the last resort will a court overturn a rule, and it is probably harder to overturn a high level rule, which is an umbrella for various specific rules, than it is to overturn a specific low level rule, especially where overturning the rule would lead to a different consequence in terms of court orders. It would be possible for two judges hearing the same case to support the same order although each judge relies on a different ratio.(96) One judge may even reject the ratio relied on by the other. The ratios which each judge relies upon might even appear to be converse. Each judge determines what will constitute alternatives in legal choice, the jurisprudential consequences of each alternative, and the consequent court orders. A legal expert system which incorporates unsettled law, should contain warnings about its uncertainties.

. Rule Types

All statements in the knowledge base must be rule statements. The rule statements in the knowledge base are data structures which ESIE will compute. The rule statements contain the choices which will be put to the user. The processing of the system is the implementation or computation of choices. The knowledge base consists of a system of rules which operates as a system of choice. Semantically, the rules are the choice controls. The system permits five types of rules or choice controls, and each is confined by its syntax as follows:

Rule Type	Syntax
1. goal (one only)	goal is <variable>
2. answer (one only)	answer is/are "<text>" <variable>
3. legal answers (one set with maximum of 50 in the set)	[legal answers is/are <variable> [<variable>]...*]
4. questions (maximum of 100)	[question <variable> is/are "<text>"]...
5. if...then rules including if...and... then rules (limited by rule line capacity of 400)	[if <variable> is/are <value> [and <variable> is/are <value>]... then <variable> is/are <value>]...

"..." means may be repeated to the maximum allowed;

"[]" means that it is not necessary to have this in the knowledge base.

The 'if...and...then' rules may contain more than one 'and'. The effect of this is that several antecedents may be combined in one rule. Some rules can only be stated correctly if this is possible. It is not correct to say that if an offer is communicated then there will be a contract. There are various antecedents, all of which must exist for a contract to be established. If any one antecedent is absent, there will be an invalidity in the negotiations; so a negative or an uncertain rule may be formulated with a single antecedent and consequence which displaces the positive result. Thus there will be a set of negative rules and a set of uncertain rules, corresponding to one positive rule. Many antecedents in the first positive rule of the CLIMS Pilot knowledge base must be satisfied to establish 'NO.INVALIDITY.FOUND', whereas 'INVALIDITY' is established as soon as a single antecedent in the corresponding set of negative rules

is satisfied. If neither a positive or negative result is established, due to uncertainty, then, an antecedent in the corresponding set of uncertainty rules is established, producing the result 'RISK.OF.INVALIDITY'.

In the rules of law, some antecedents, be they positive, negative or uncertain, must be combined by 'and' and some must be combined by 'or' connectors. However, the ESIE rule forms preclude any processing of a logical disjunction of the antecedents in a rule. The system does not allow for 'either ... or' rules.

Consequently, where an 'or' connector applies, each alternative antecedent must be set out in a separate rule. In the CLIMS Pilot, the several treatment of negative and uncertain rules and choices removes the need to consider the various combinations of negative, uncertain and positive antecedents which could lead to a combinatorial explosion of choices. Several treatment in the ESIE system also means that the inference engine will report on the first found invalidity and will not report all invalidities. If the negative antecedents were combined by conjunctions in a single rule, then this would capture only one sort of case of invalidity. If all the alternative combinations of positive, negative and uncertain antecedents are set out in various rules, then the negative result will take longer to process with no better advice.

. Length of Variables, Values and Text

Rules contain variables and values according to the specified syntax of the system. The variables and values in a rule are limited to a maximum of 40 non-blank characters each. The limitation of these strings may require the use of abbreviations and combinations of abbreviations of concepts in a rule of law. A full stop may be used to join terms in order to maintain some ordinary language. For the purposes of designing a jurisprudential system, one variable and one value in an 'if...then' rule line may be understood as a monad. The concept of the monad can be used to refine jurisprudential control over the legal knowledge in designing and constructing a legal expert system. In a knowledge base, a monad could be any symbol, even a numeric symbol, as long as it represents the structure of the legal knowledge, given the questions put to the user and the

user's input. Monads are a processing device; they are the units in legal choice patterns. Through user input in response to questions, monads are established, directly or indirectly .

A monad may be a consequence in one rule and an antecedent in another rule. In this case, the rules are linked together by the common monad. Monads may be established in a reasoning chain through this sort of linking. Monads are chained together in rules and rules are chained together by common monads. In the CLIMS Pilot, one question serves a set of three alternative monads: the positive, negative and uncertain. The answer acts as a selection of one of the three. The rules of the system could be seen as the rules for putting questions, dealing with legal answers from the user, and giving an answer to a user i.e. as the rules of legal dialogue. Legal propositions, containing monads, which are computational, constitute the question-answer logic of a system of legal choice. The questions are points where choices must be made. A question and the system's legal answers indicate the alternatives. The selection of a legal answer, is the selection of the alternative.

The text of any question is limited to a maximum of 80 characters, including blanks. The same limitation applies to the text of the answer or conclusion produced by the system. These lengths considerably limit the natural language dialogue in the user interface, and the extent of the semantic processing. The drafting of the knowledge base had to be efficient and precise.

. Trace

ESIE allows a user to trace the processing of rules by the inference engine. Natural language variables and values enhance the trace. An example of the trace in a CLIMS Pilot consultation is as follows:

- - trace on

There were 278 rule lines, 23 questions and 3 legal answers specified in the knowledge base.

= => go

Currently looking for : CONTRACT.STATUS.

Currently looking for : OFFERCOM.

Currently looking for : COMMUNICATION.

Has your offer been

communicated to the offeree ?

yes

It has been learned that COMMUNICATION
is YES.

Currently looking for : OFFERCOM.

It has been learned that OFFERCOM is OK.

Currently looking for : CONTRACT STATUS.

Currently looking for EXPIRED.

Currently looking for HAS.EXPIRED.

Has your offer expired ?

yes

It has been learned that HAS.EXPIRED
is YES.

Currently looking for : EXPIRED.

It has been learned that EXPIRED
is NOT.OK.

Currently looking for CONTRACT.STATUS.

It has been learned that CONTRACT.STATUS
is INVALID.

The status of your contract is INVALID

I have completed this analysis.

= => exit

Have a nice day !

It is evident from this screen information that the trace is not user friendly. The limitations on variables and values restrict the use of the trace function in providing reasons for questions and conclusions. There is no opportunity to discover the reason for a question or answer except through the trace function.

. Legal Answers to Questions

There can be only one set of legal answers that applies to all questions. The system allows a maximum of fifty answers in the

set. In the CLIMS Pilot, the legal answers are: yes, no, or do.not.know. It would be difficult to use any other legal answers, as the user may select any of the legal answers to respond to a question. Legal answers must therefore be appropriate to all the sets of alternatives for which there are questions. The only portable set of legal answers are those which are based on truth, namely affirmative (yes), disaffirmative (no), and uncertain/unknown (do.not.know). Questions must be designed accordingly. If legal answers were not included in the system at all, then it might prove difficult to run, since the inference engine will only operate the rules if the user's answer matches a value in a rule. The user is advised of the legal answers if the user gives an answer which is not a legal answer.

. Answer

There can be only one form of conclusion or system answer which, in the CLIMS Pilot, is the type of contract status. The text of the answer must be expressed in a maximum of 80 characters which include blanks. This greatly limits the advice which the system can give.

. Order of Rules

Although there is no requirement to place the rules in any particular order, some design in the sequence of contract rules or choices is necessary to ensure optimum processing of information and delivery of advice. The order in which legal rules or choices are considered is a component of legal knowledge. The author of ESIE, Edward Reasor, explains the process of the inference engine in the following way:

The "stack" in ESIE is used to keep information that ESIE is currently looking for. It functions along a precognitive state that humans use in information gathering. i.e: we need to find out if item x is true, but to do that we need to know if item y is true, and to know about item z. Therefore, what we really want to know is x, which is pushed onto the stack, then item y, then item z. Naturally, the GOAL is the first thing pushed onto the stack in ESIE.

Items are popped off the stack when knowledge about the item is learned or none can be found. If no information on an item can be found, then ESIE will look through the rules for another item to solve the currently looked for item and push that on the stack.

The CACHE holds all learned information. It functions as a basic quick retrieval storehouse.(97)

By the stack mechanism, rules are considered, as they become relevant, and in the order in which they are set out in the knowledge base. The goal, contract.status, which is the variable in the goal rule, is the first thing to be pushed onto the stack. The inference engine will then take, in turn, the rules in the knowledge base which contain the term contract.status. The variables in the first 'if...then' rule, which is selected, because it contains a contract.status consequence, are pushed onto the stack in the order in which they appear in the rule. In the CLIMS Pilot knowledge base, the first of these variables does not have a value which is one of the variables in the legal answers rule. If a variable on the stack has a value which is the same as one of the legal answers, then the system will put to the user the text of the question rule for this variable. Otherwise, if a variable has a value which is not a legal answer variable then the inference engine searches for the next rule in the knowledge base which contains this variable and has the same value as a consequence in the rule. If there is such a rule, the variables in this rule are pushed onto the stack, and so on. The process is observable through the trace sample given above.

The inference engine searches through the rules until it finds the links in the chain of reasoning. There may be links that are variables which do not have values the same as a legal answer. There may also be links that are variables with values which are the same as one of the variables in the legal answers rule; then the system will put to the user, in sequence, the texts of the question rules for these variables. The inference engine either puts a question to the user or continues to search the rules, depending on whether or not the variable which is currently first on the stack, has the value of a legal answer variable or not. A rule will be either satisfied or discarded. If it is discarded, the inference engine will test the next rule, and so on until a

rule is satisfied. In making a specific search for links in variables and values, that is, in searching for rules which will assist the testing of the current rule which is being considered, the engine does not consider each rule in relation to the current database in the cache. It does not match every rule against the database every time a new item is added to the cache. Only when a rule fails, following input, will it be discarded. Then there is a general search for a new rule that is consistent with the current data in the cache. The next rule which is consistent with the information in the cache is then processed through the stack. The two forms of rule search, namely the specific search to satisfy a rule, and the general search to find a rule to test, are not carried out simultaneously. Rules are considered in turn, one at a time.

As information is needed to determine the applicability of rules, questions are put to the user and input determines either that an answer can be given, or that another rule and further input should be considered. The trace indicates what has been learned that is transferred to the cache, and what the inference engine is currently looking for, by virtue of what is on the stack and the rule that is being considered. Variables are transferred from the stack to the cache, as they are set to values according to the legal answers given by the user to the variables' questions. Legal answers in the legal answer rule are variables but the user's legal answers, the inputs, are treated as values. This process continues until variables and their values in the cache, which are the user's instructions, are complete to the point that a rule which produces a conclusion is satisfied. An answer is given accordingly. As soon as the variable in the goal rule is set to a value, on the basis of user input, that value becomes the variable in the answer rule and that answer is given. The inference engine process is 'chaining' from variables to values to variables to values etc. until a value becomes the answer variable on the basis of the user's values that have accumulated in the cache. Whatever is learned from the rules and the user's answers, is stored in the cache like a database.

In the order of the rules in the CLIMS Pilot knowledge base the two major rules that will achieve a positive result are placed

first. Next come the corresponding invalidity rules, followed by the corresponding risk of invalidity rules. After this, there is a rough order of more specific rules which will establish the value of the variables in the major rules by reference to user input. The effect of this is that the inference engine will look for invalidities before it reports a risk of invalidity. The priority of specific search over general search, and the several statement of the invalidity and uncertainty rules ensures this. An invalidity is a more certain consequence than a risk of invalidity. So the system is designed to give the more certain consequence in preference to an uncertain consequence.

For example, if the user's input establishes that offercom is ok.not.ok so that the first two 'if...then' rules fail, the system will take the next rule which is consistent with this information, namely, 'if expired is not.ok then contract. status is INVALID'. It will not immediately apply the rule further down the knowledge base that 'if offercom is ok.not.ok then contract.status is RISK.OF.INVALIDITY'. This rule will only be applied if all the rules stated before it fail.

The inference engine reports an invalid contract status as soon as an invalidity is found. It is not capable of reporting all invalidities and all risks of invalidities. The only way of discovering these is by another consultation giving a false response in the place of the response which produced the invalid status, so that the next point can be dealt with. If one of the first two positive rules is satisfied, then the inference engine immediately reports the contract status, 'NO.INVALIDITY.FOUND'. There is no need to process the negative or uncertain rules because their contraposition to the positive rules means that once a positive rule is established then ipso facto, no negative or uncertain rule could be satisfied. ESIE requires a clear statement of all paths. It will not 'assume' that if there is no positive result then a negative result should be given. The inference engine is a logic mechanism, only to the extent that it is a chaining mechanism. It will chain through the logic patterns in the knowledge base. The logic patterns must be spelt out completely in the knowledge base if the chaining is to produce an accurate result.

Further study could be made of the alternative processes which alternative arrangement of the rules in the knowledge base might produce. It might be expected that such a study, firstly, would reveal jurisprudential complexity at a deeper level, and secondly, might identify the sort of techniques that could be used for the control of this complexity. It was considered that this study should not be undertaken because the shell was too limited for such focal work. Part of the complexity would be due to the inability of ESIE to process 'or' connectives in its rules. More developed software can process 'or' rules.

(3) ESIE does not have a specific tool to allow a selection of questions depending upon the legal role required by the user. For instance in the formation stage, legal roles include offeror and offeree. A selection of roles, as roles change, could be achieved through a complex development of the rules. To simplify the rules, the CLIMS Pilot was designed for an offeror. It advises an offeror whether or not there is any invalidity or risk of invalidity in the offer. The questions are framed from the perspective of an offeror. Understanding the offeror's position might still be helpful to the offeree. If the shell did permit a pre-selection of role, offeree dimensions could be built more readily into the system. A blackboard system might run various roles relative to each other. Different perspectives may entail alternative or parallel consequences or interim consequences for a common set of antecedents.(98) A role-neutral position could be adopted to view any role perspectives along any path. Many of the questions in the ESIE knowledge base are expressed in neutral terms. However, a neutral position throughout could give the interface the appearance of an information system rather than a communication system between lawyer and client.

(4) ESIE does not have a specific tool to allow a selection of questions depending upon the stage of the user's transaction. Again, this might be achieved through a complex development of the rules. The CLIMS Pilot knowledge base assumes to some extent that the transaction may have gone beyond the communication of an offer; for instance a question on revocation would not be appropriate unless an offer were already communicated. The system might have to be consulted repeatedly as a transaction proceeds or

as a situation develops. A time stabiliser would be an enhancement of the shell. This would require the development of jurisprudential time modules.

(5) ESIE has no means of providing definitions of terms for the user like a dictionary. If the user can not answer the question due to a lack of information, a do.not.know answer can be given. Then the system may put further questions which will effectively amount to a refinement or further definition of the original question.

(6) ESIE, as a rule-based system, may be suited to the construction of small advisory legal expert systems. However, the dimensions of legal expertise go beyond this. Users with commercial purposes, may require a legal expert system as a planning tool. In the case of a contractual transaction, a jurisprudential system could be devised to advise on the optimum or most profitable path for a transaction. Some rules of contract law may be used to give a party advantages or reduce risks of loss or conflict. There is a cost-benefit aspect of law. Advice might be required at many different points of a transaction or it might be required to assist in planning the best way of proceeding through a transaction to prevent or solve a conflict. For instance, in a contractual transaction, a party who is in breach of a contract is affected by the rules regarding breach in a different way from the party who is the victim of the breach. The artificial lawyer must be able to advise each. The advice might be concerned with the formulation of legal argument, or it might be an opinion about what the user should do or not do. The sort of legal environment needed is one which would provide jurisprudentially robust dimensions and processes necessary to emulate relative legal reasoning efficiently. ESIE is not suited to the automation of this sort of expertise. Nor could other services of the legal expert be emulated by ESIE. Professional tasks of drawing documentation and conducting procedures to achieve a series of legal ends could not be carried out within the scope of the ESIE shell.

(7) ESIE will process an ASCII or flat file. This makes the system portable to a great variety of computers. The knowledge

base was constructed as an ASCII file using the ENABLE word processing system. Any word processing system which allows files to be saved as ASCII files, may be used to construct the knowledge base.

The constraints of ESIE provided an indication of the additional facilities which a legal knowledge engineering environment should have. It was clear that, although ESIE could automate the application of rules of law to a particular case, and provide some limited advice about this process and the overall conclusion, the user would find it difficult to understand exactly what the law was and the advice given might fall short of the user's requirements. The first Pilot is an artificial lawyer with limited perspectives. A good artificial lawyer needs to be able to think relatively and communicate all relative thinking as required. Subsequent CLIMS experiments explore further aspects of simulating relative legal reasoning and explanation.

iii. Knowledge Representation

The first CLIMS Pilot experiment was concerned with the potential use of jurisprudential systems in legal knowledge engineering. The knowledge base is a specific jurisprudential system. The term, 'jurisprudential' is here used to mean 'concerning the rules of law'; it includes the heuristics of practitioners, and rational extensions of primary source law. It is a legal wisdom system. The term legal system usually indicates a jurisdiction of established law and its administration, so it is not an appropriate description of the semantics of a legal expert system, be it a knowledge base system or some other sort of legal expert system.

To distinguish specific jurisprudential systems which are computational, from those which are not computational, the legal data of a legal expert system is here termed a jurisprudential geometasystem. The prefix 'geo' indicates that this metaphysical part of the system can be installed and processed as a physical system, albeit a system of symbolic digits. Furthermore, it will usually be the case that there is some geometric scheme implicit

in a geometasystem, involving some jurisprudential geometry, such as a net or a tree.

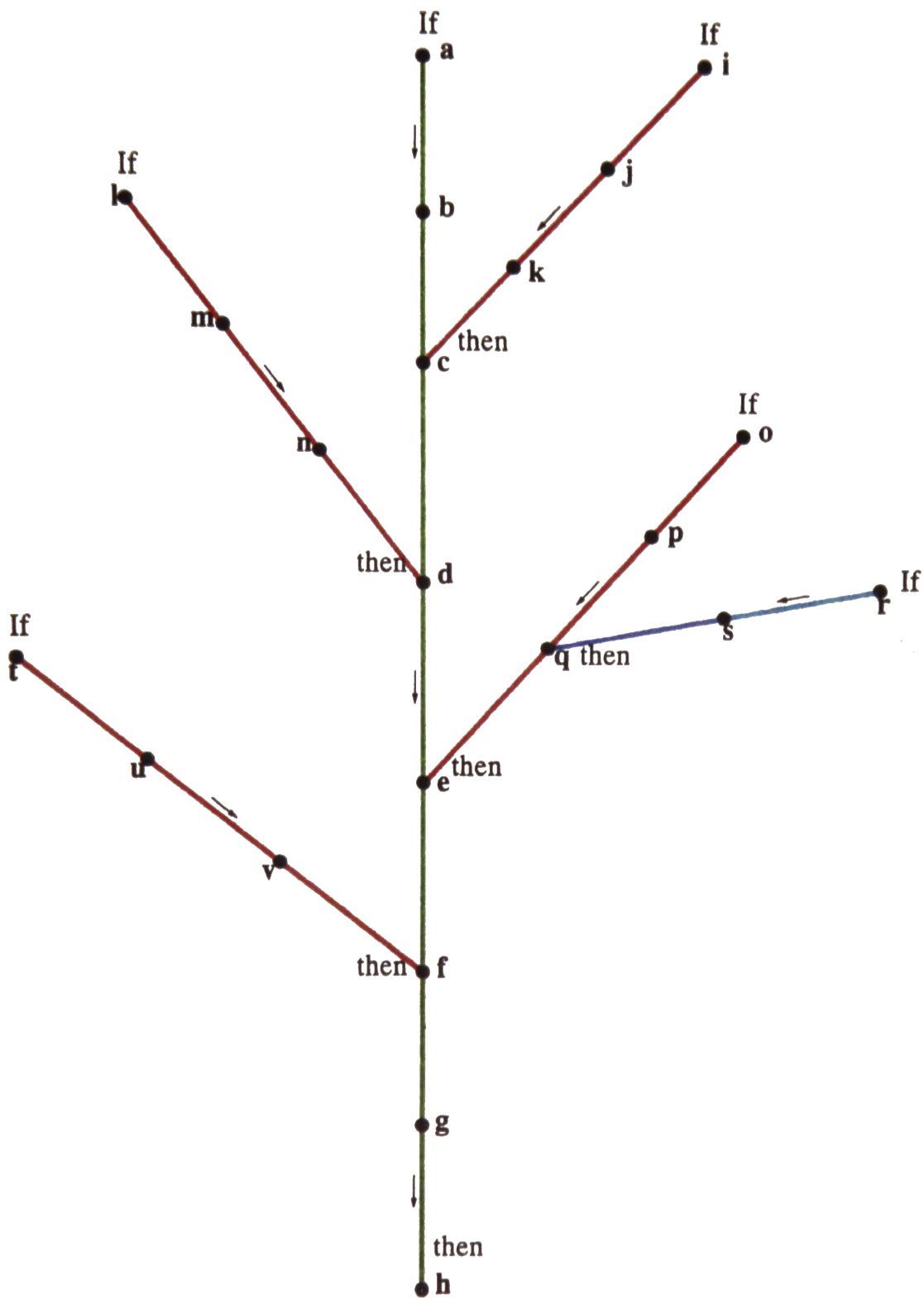
In the course of construction of the jurisprudential system for the first pilot, the author attempted to use a tree graphic as the design aid to determine the content of the rules, the order of the rules, and the associated questions. It soon became apparent that a tree was not the natural shape of the knowledge structure. Perhaps the knowledge could be broken into a series of fragmented or linked trees for a finite state machine, a procedural program, or production rule system. However, a complete jurisprudential representation of the knowledge is first required in order to determine how trees might be derived so as to design the search system. For ESIE, which demands an holistic semantic system, a river paradigm was required to represent the contract knowledge graphically. The knowledge flows in a system of tributaries. The data structures for the geometasystem were designed with the aid of a riometasystem model. A riometasystem could be regarded as a particular sort of tree; if so, it is the river sort. A three dimensional riometasystem is similar to the paradigm of a molecule. It can also be contained in a sphere or world; as such, it is a paradigm for an artificial legal brain with two hemispheres.

The river paradigm, which is a system of tributaries leading to a single conclusion, is derived from the structure of legal argument based on one adversary position. This structure can be seen in arguments which are commonly presented by leading counsel as the framework of a case.(99) Essentially, each of the major components required to maintain a claim have to be established by sub-component factors, each of which, in turn, have to be established by a set of evidentiary facts. To counter the claim, the opponent negates or raises doubts about each of the components, sub-components and relevant evidence, usually with the same order of reasoning. The river graphic is derived from the heuristics which are implicit in presenting this sort of argument. These heuristics have fashioned the communication between counsel and the judiciary which, in turn, has moulded legal theory.

Figure 5 is a form of river knowledge. A river leading to a positive result contains all the positive antecedent monads. In the counter argument river, all the positive antecedent monads are negated and the final consequence is negative. Another sort of legal river is the uncertainty river. If points can not be negated then they may be doubted. In the uncertainty river, all antecedent monads are uncertain and the result is uncertain. The opponent who relies on the uncertainty river must argue that a positive result can not be established because the final result is uncertainty. The uncertainty river is a useful model for developing arguments to suit the two burdens of proof: the criminal burden of 'beyond a reasonable doubt' and the civil burden, 'on the balance of probabilities'.

In the river paradigm, each tributary constitutes a rule. A tributary commences with 'if', and the monads which follow make up the stream which terminates with the monad which follows 'then'. In Figure 5, nodes a, b, c, d, e, f and g represent the antecedent monads which have the consequence, monad h. Any monad on the primary stream, including the consequence monad, may have a secondary stream which more closely defines it. Any secondary stream monads may be more closely defined by a tertiary stream and so on. Broadly, tributaries flow from the top of the watershed, the highest points upstream, down to the mainstream which terminates in the final outlet at the sea, the outcome of the case, where it might be that the parties are released from the jurisprudential system back into the non-litigating multitudes. There is a unidirectional flow, from high to low, which represents the flow of legal reasoning.

Tributaries intersect at points where they share a common monad. A monad which is a consequence in a secondary tributary might intersect a mainstream tributary in which the same monad exists as an antecedent. The intersection will occur, at the last monad of the secondary tributary, that is, the consequence monad, and at the position of the antecedent which is the same monad, in the mainstream tributary. The point of intersection is both a consequence for one rule and an antecedent for another rule. The river system is a paradigm of interlocking rules. Monads in rules



A SYSTEM OF RULES

- PRIMARY STREAM
- SECONDARY STREAMS
- TERTIARY STREAMS

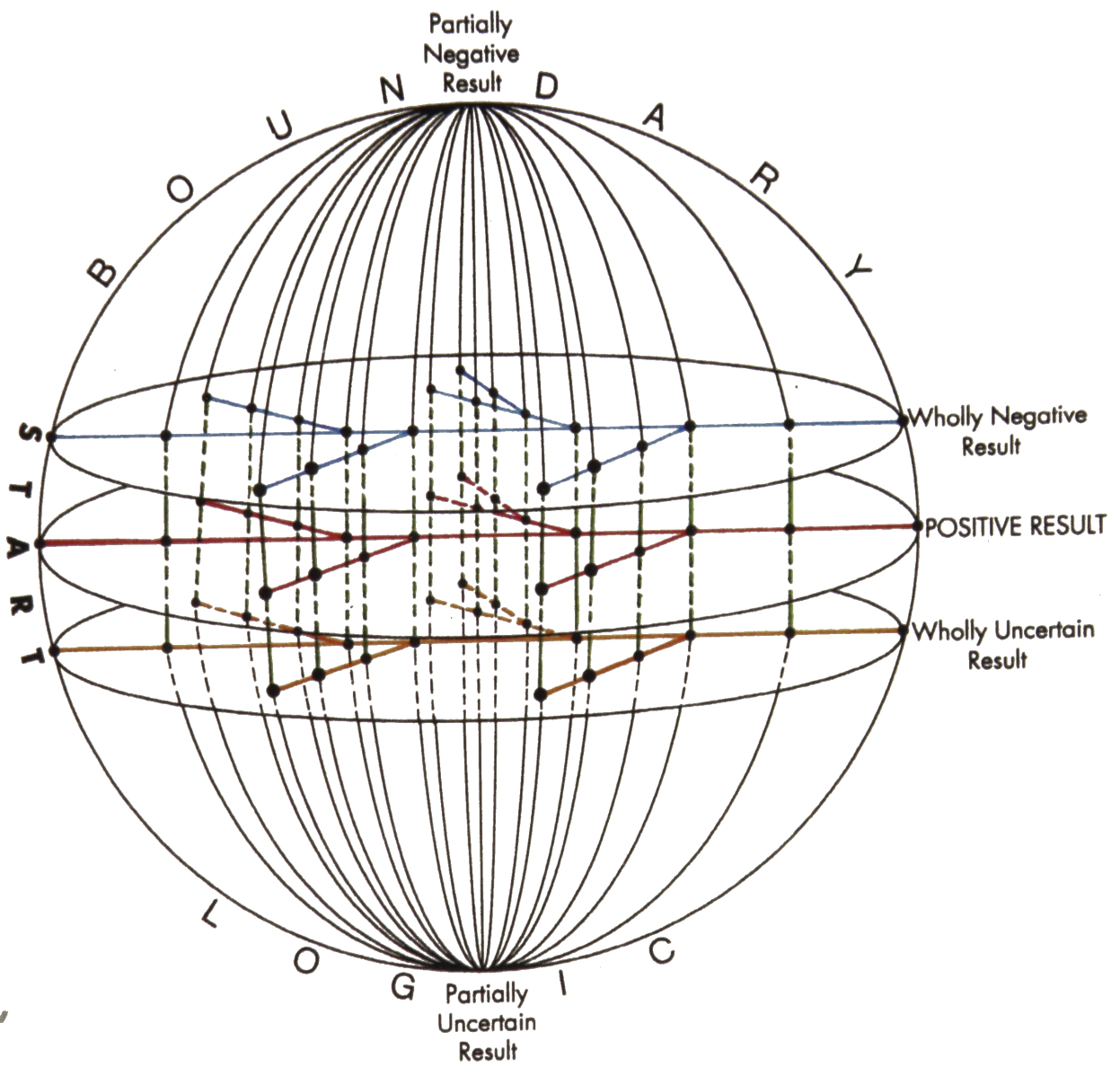
Figure 5

are placed in relation to each other according to the interlocking system.

In the design of the CLIM jurisprudential system, the world of rivers paradigm was developed in the representation of the knowledge. Figures 6, 7, and 8 illustrate the development of the world of rivers paradigm as a design aid. These figures do not represent the CLIMS Pilot knowledge base exactly. They are prototype models, prima facie suited to legal knowledge. The CLIMS Pilot knowledge is a variation of these prototype models. Positive, negative and uncertainty rivers are linked. Conditions required for moving between the three rivers and the consequences of such processing have to be specified. The world of rivers paradigm assists in the design of the system rules or data structures. It is a jurisprudential paradigm which is a design aid for legal knowledge engineering.

In order to develop the world of rivers graphic, first, positive rules were streamlined on a two dimensional plane as the positive river system. This two dimensional plane is located as the plane which cuts a sphere into two halves, the equatorial plane of a world. Next, negative rules were set out in a corresponding river system on the tropic of cancer plane. Finally, uncertainty monads were set out in a corresponding river system on the tropic of capricorn plane. The three planes are linked by streams where there are corresponding monads. Corresponding uncertain, positive, and negative monads, such as 'offercom is ok.not.ok', 'offercom is ok', and 'offercom is not ok', are called triads. They are linked by triad streams.

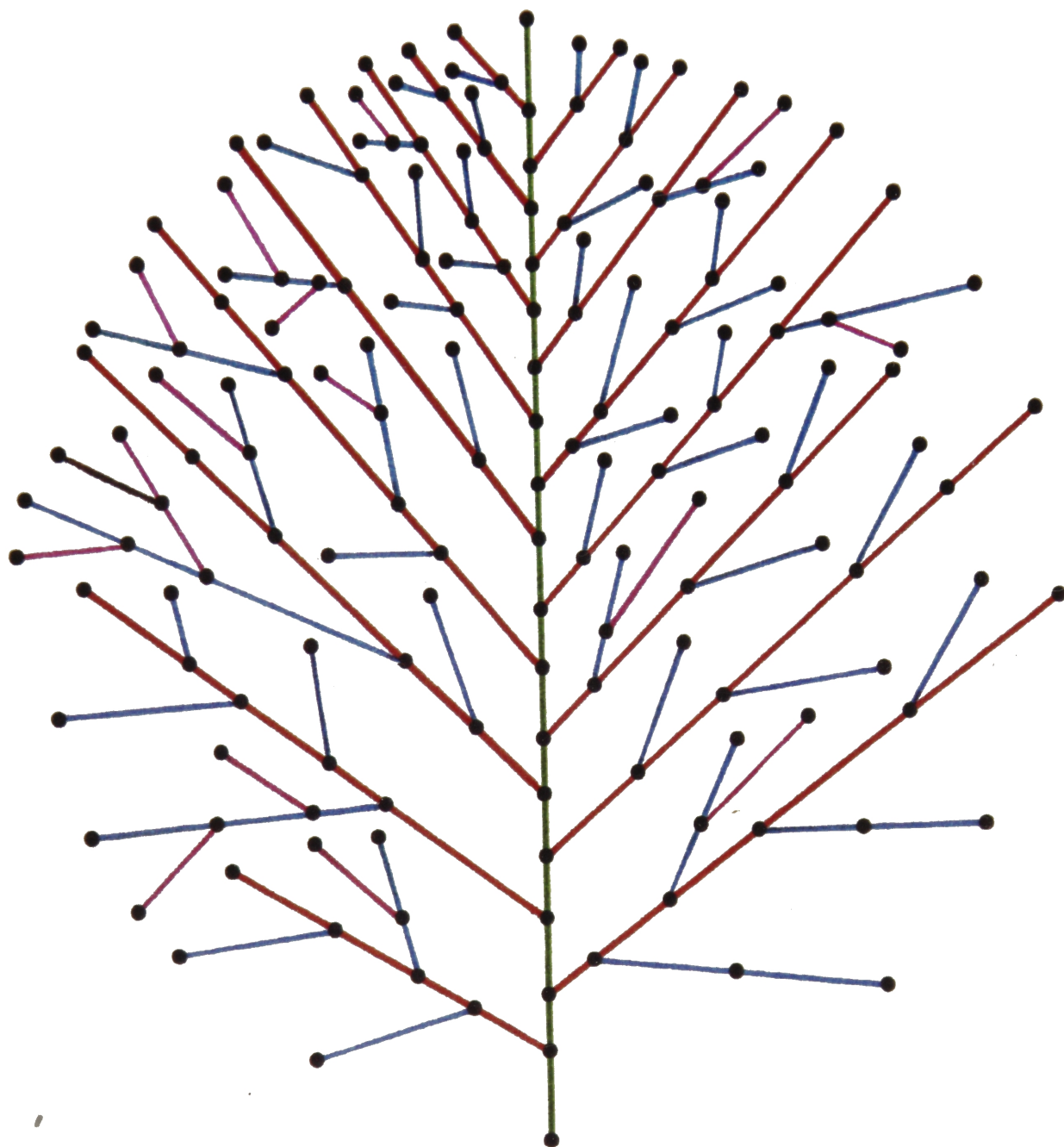
A consultation path is a journey through the combined river systems. So, if a monad on the positive river system is negated in a consultation, then the triad stream takes the user from this monad, to the corresponding negative monad on the negative stream. This negative monad is then established. Depending upon the order of application of rules, the negative monad will be established initially as either a condition or an antecedent. If there is an uncertainty about a monad on a negative stream, then a triad stream takes the user to the corresponding positive monad, on the



RIOMETASYSTEM

- — POLE STREAMS
- — TRIAD STREAMS
- — NEGATIVE STREAMS
- — POSITIVE STREAMS
- — UNCERTAIN STREAMS

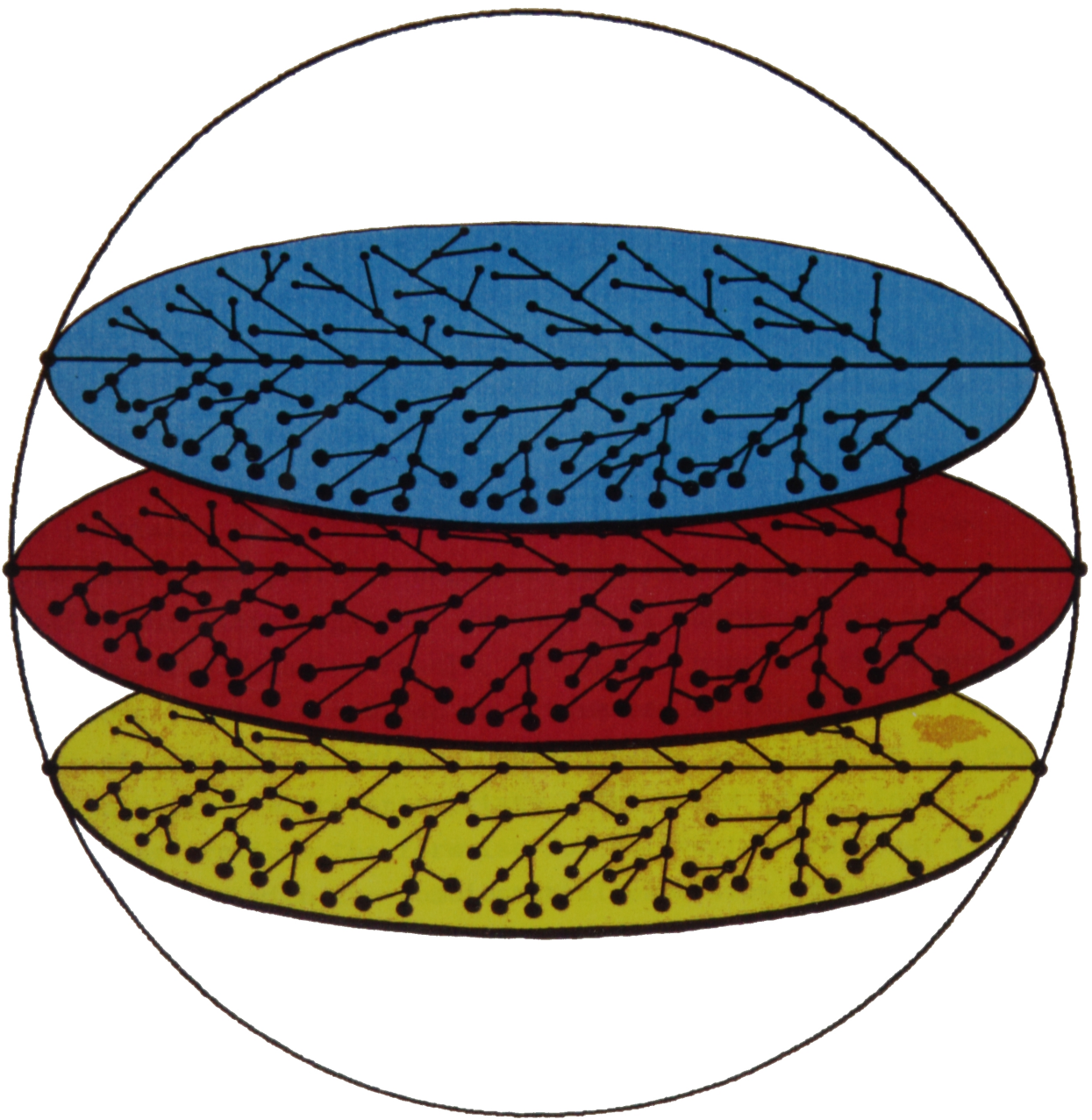
Figure 6



A RIVER SYSTEM

- PRIMARY STREAM
- SECONDARY STREAMS
- TERTIARY STREAMS
- QUATERNARY STREAMS
- QUINARY STREAMS

Figure 7



THE WORLD OF RIVERS PARADIGM

- NEGATIVE
- POSITIVE
- UNCERTAIN

Figure 8

positive stream, and then to the corresponding uncertainty monad; the uncertainty monad is then established.

An all positive journey ends at the point where the international date line crosses the equator: this results in the positive conclusion which, in the CLIMS Pilot is 'NO.INVALIDITY.FOUND'. The corresponding all negative journey ends at the intersection of the tropic of cancer and the international date line, with the cancer conclusion 'INVALID'. ESIE is not capable of taking an all negative journey; it reports an invalidity as soon as one is found. However, inference engines can be designed to provide for an all negative journey, as demonstrated in the CLIMS Pilot No.2 experiment. Finally, the all uncertain journey emerges at the intersection of the tropic of capricorn and the international date line, with the capricorn conclusion 'RISK.OF.INVALIDITY'. Any mixed positive-uncertain journey will end at the south pole, which is a partially uncertain result, 'RISK.OF.INVALIDITY'. Prima facie, any mixed positive-negative, uncertain-negative or positive-uncertain-negative, journey will emerge at the north pole as a partially negative result, 'INVALID'; however, there may be exceptions to this which can be determined by reference to the nature of the positive river. Pole streams are added to achieve a pole consequence where appropriate. The world scheme for conclusions provides the formulae for delivering the final result and for dealing with the combinatorial explosion of mixed journeys. A distinction is made between a tropic result and a pole result to assist in the design of systems which can report on all the points which support the conclusion. The distinction also adds clarity to the jurisprudential system.

The streamlining for the CLIMS Pilot commenced with the two positive mainstreams, the first two "if...then" rules in the knowledge base. These two rules are contiguous mainstreams which part at one point only:

if offercom is ok
and expired is ok
and consideration is ok
and rejection is ok
and revocation is ok

and request is ok1
and reasonable is ok
then contract status is NO.INVALIDITY.FOUND

if offercom is ok
and expired is ok
and consideration is ok
and rejection is ok
and revocation is ok
and request is ok2
and reasonable is ok
then contract.status is NO.INVALIDITY.FOUND

The point of departure lies in the monads 'request is ok1' and 'request is ok2'. These monads create an island effect. Whether or not an offeree has requested information about an offer, does not affect the ongoing course of negotiations toward a contract. If entry to one side of the island is blocked by input, then the same input opens the other side of the island.

The monads of each rule, or stream, have a sequence which is largely in accordance with a temporal logic. This temporal logic is part of the logic of legal choice. Thus, it is not appropriate to consider if an offer has expired until it is first established that an offer has been communicated. Once it is established that an offer has been communicated, it is not appropriate to investigate if the offer is valid, until it is established that it is still open, that is, unexpired. If it is the case that it has been communicated and has not expired, then it is appropriate to find out if it satisfies the major requirement for validity, namely that there is consideration given by each party. If there is consideration, then there is a valid offer. To proceed from this point to a contract, it must be established that the offer has not been rejected or revoked. An offer can not be revoked if it is already rejected. Therefore, rejection should be explored before revocation. An offeror need only be concerned with revocation, if the offer has not been rejected. Dealing with rejection before revocation, would also be appropriate if the system were expanded to incorporate acceptance. If an offer is rejected, there would be no need to consider if revocation was

communicated before acceptance, in order to evaluate revocation. Rejection would be considered before acceptance, since an offer can not be rejected after it is accepted.

The temporal logic in the order of monads, provided some economy in time required to run the system. If an offer has expired, then subsequent monads become irrelevant, and their questions are not put to the user. If these questions were put, they might appear nonsensical. The limits of ESIE, in that it could not report all invalidities and risks of invalidity, avoids the problem of considering the appropriate limits of an investigation, given accumulated information. However, a system might investigate all arguments of invalidity, in case the argument of expiration fails. If an offer has not expired, the validity of the offer becomes important. If there is no consideration, subsequent monads become irrelevant, but could be investigated to complete the arguments, and so on. There are difficulties in reconciling a thorough investigation and the point at which the continuation of the investigation becomes nonsensical.

It may be difficult to match the law to the facts of a case. Counsel's skills are required for the formulation of questions and the order of the questions. The order of questions must appropriately match the order of monads. Questions are not asked of a witness, by counsel, without a proper basis. Thus, before the question whether the offer has been revoked is put to the user, there is first established through other questions, that the offer has been communicated. Counsel may ask a witness to make assumptions in answering a question, but there are limits to the sort of assumptions which a witness can be asked to make. These limits can be a guide to the formulation of a system and monad questions.

Monads in a positive stream may have disaffirmative elements e.g. in the first if...then rule, the monad, 'rejection is ok' means that there is no rejection of the offer. The positive mainstream has a combination of affirmative and disaffirmative elements: offercom is OK (there is communication of an offer), expired is OK (the offer has not expired), revocation is OK (the offer has not been revoked), consideration is OK (there is consideration in the

terms of the offer) and so on. Likewise, negative monads may contain affirmative elements. Uncertain monads are associated only with uncertain elements, represented in the CLIMS Pilot by the legal answer, do.not.know., and the value ok.not.ok.

In the design of the jurisprudential system, legal knowledge engineering fictions were employed, namely 'ok', 'ok.not.ok', and 'not.ok'. These fictions assisted in the identification and stabilization of the positive, uncertain and negative monads. They served to distinguish: goal positive from fact affirmative; goal uncertain from fact uncertain/unknown; and goal negative from fact disaffirmative. Questions could then be prepared with less confusion. Questions did not have to be framed in such a way that the legal answer 'yes' would always have to be given to achieve the positive result, and correspondingly, 'no' for the negative result and 'do.not.know' for the uncertainty result. Legal theory does not have concepts which assist with goal orientation. Some legal practitioners have developed perspectives on the law to enable them to advise clients about goals. These perspectives have not been explored as theoretical subject matter to be integrated with legal theory. The heuristics of arguing for litigation goals are a part of goal-oriented legal theory. However, people may have goals outside of the litigation context. They need to know the legal paths which they must choose to attain these goals. The use of fictions to establish goal paths should not be confused with the abbreviations of legal concepts that were necessary because of the string limits on variables and values.

The river paradigm is a paradigm of legal choice. Legal knowledge has thousands of monads from which choices may be made. Various combinations of monads are possible. However, in the river system, each monad has one location in regard to the others and can only be chosen according to the flow of legal reasoning from one monad to another. If a legal concept could appear in more than one place in the river, then it must be given separate monad identities. For instance the rejection of an offer is not treated the same as the rejection of consideration on delivery. Different questions must be asked to establish each. Monads may be repeated in a knowledge base in order to achieve some particular form of processing. However, semantically, in the jurisprudential

geometry, they are constant and fixed as in the semantics of the world of rivers. The geometry of the world of rivers might be seen as a form of semantic net. Monads may be accessed at random but they are only legally effective according to their semantic order.

The CLIMS Pilot inference engine will only put questions to the user if the information is required to find out if a rule, that is currently being processed or considered, applies. The system collects relevant evidence or choices to test and find relevant rules. In a consultation, there is an orderly testing of one rule at a time. ESIE does not have the flexibility to jump back and forth from testing one rule to testing another. A blackboard system might do this in an orderly fashion. Each stream is potentially a piece of the user's jigsaw. The completed jigsaw makes up one alternative journey through the river system. The order for testing rules is limited by the program of the inference engine.

In the CLIMS Pilot, the program establishes the monads of the user's case. The program is designed by reference to the order in which monads are to be established, from rule to rule. In the CLIMS Pilot, a user is first asked to provide input to establish whether or not each of the monads in the first positive mainstream exists in the user's case. The order of rules in the CLIMS Pilot knowledge base ensures that the positive mainstream would be considered first. The riometasystem journey begins at the first antecedent monad at the top of the first positive mainstream. The journey proceeds by monad questions, input and automatic propulsion. There are no questions for the antecedent monads of the first rule. The system then proceeds automatically to the top of the first secondary stream for the first monad. There is only one antecedent monad in the first secondary stream, namely 'communication is ok'.

In a riometasystem, a secondary rule may be viewed as the finer definition of an antecedent monad in a primary rule. A tertiary rule defines an antecedent monad in a secondary rule, and so on. A rule stream which defines a monad, intersects another stream at the point where the monad occurs in this other stream. The finer

the definition upstream, the more specific will be the question to establish the monad. Questions which establish the existence of a monad in the user's case may be available for every monad, or may only be available where monads most closely approximate evidence. In the CLIMS Pilot, questions were available at secondary levels for some of the monads in the mainstream. Rules were specifically developed in the knowledge base to accommodate a user's legal answer, 'do.not.know'. These rules were designed to explore the meaning of monads through to their secondary origins in the tributary structure and so identify more closely any monad uncertainties.

The tributary structure might be developed with tertiary streams feeding into secondary streams to deal with uncertainties on secondary streams, and so on to the minutiae of cases in the watershed origins of the knowledge. The hierarchy of streams reflects the granularity of the legal knowledge. The mainstream contains the most general or abstract legal concepts as monads. This is not to say that all the antecedent monads in the mainstream or other streams will have the same level of generalization or abstraction. Antecedents in the same stream might vary in their degree of generalization or abstraction. Necessarily, the consequence in a rule will be at a higher level of generalization or abstraction than an antecedent. The number of subsidiary streams which a mainstream monad has, is an indication of the level of generalization or abstraction. Legal theory does not maintain a constant expansion of particularization for all monads. Particularization depends upon the issues raised in cases which come before the courts.

In the design of a legal expert system, the legal knowledge engineer might decide on the nature of the user interface by reference to the level of granularity where questions will commence. The higher upstream, the finer the granularity. Questions which establish monads will vary with different evidentiary levels of the monads. The further upstream, the more specific will be the evidence required to establish a monad. Specific information may be used to establish the most general or abstract monads downstream, so that the user will not be asked initially to confirm a very general or abstract state of affairs.

The order of establishing monads, in terms of granularity, may be varied to suit different requirements. The opportunity to answer a very general or abstract question first, is an opportunity to avoid a great many questions where some matter is clearly not in doubt. It also orients the user for more specific questioning. This was the course adopted in the CLIMS Pilot.

The tributary structure might assist in the design and location of a suitably adapted Tyree vector case retrieval module in a legal expert system. Alan Tyree's vector system, FINDER, suggests a way of dealing with the evaluation of evidence in order to determine if a monad exists. Some monads are established by an evaluation of the evidence rather than by the application of a rule. In terms of legal choice, this means that a choice is made by weighing up the various factors for and against a particular selection, rather than selecting conditions and antecedents from which a necessary consequence is automatically selected. Where the rules run out, in the watershed areas of the riometasystem, a tributary could take the form of a vector structure rather than a rule. The vector sub-system could produce the closest case, given a range of factors, some or all of which, cumulatively, could establish the monad. On the basis of the closest case, a consequent choice is made. The user selects the factors for automatic weighing and matching, and automatic implementation of the consequence of the weighing and matching process. ESIE does not have a vector tool.

For the primary monad "offercom is ok", secondary streaming was explored at some length, as can be seen in the knowledge base. Several positive secondary streams feed into the monad 'offercom is ok', as alternative ways of establishing this positive monad. They fan out and meet at the same point of intersection, namely the primary monad. This is illustrated in Figure 9. The fan of tertiary streams could be linked by directional arcs, to indicate the order in which rules should be considered. Such linking gives the tributary structure a lace pattern. In the knowledge base, these rules were developed sufficiently to demonstrate how a fan of streams might be automated. Secondary monads should bring the system closer to the fact situation of a case. An examination of some of the journeys which ESIE can be notionally understood as

SAMPLE OF OFFER TRIBUTARY

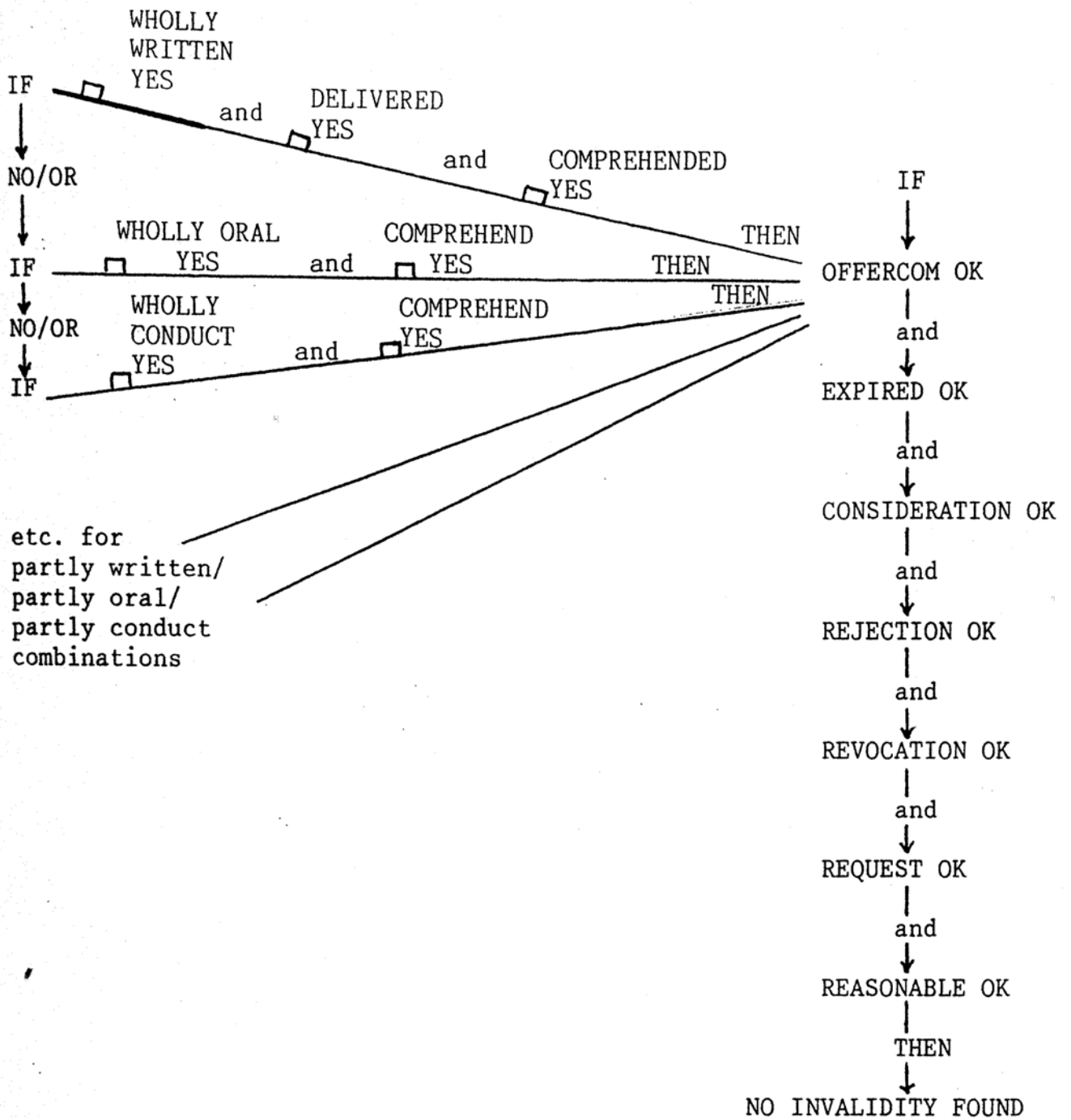


Figure 9 Fan of Rivers

making, reveal more of the nature of the jurisprudential system which is automated.

In the GLIMS Pilot, the first secondary stream (which is not marked in Figure 9) is established through input in general terms. If the user is uncertain about the antecedent monad in the first positive secondary stream, and gives the legal answer, 'do.not.know', then the uncertain monad, 'communication is do.not.know' is established in the plane of the tropic of capricorn. The path of the user has dropped out of the equatorial plane, via the triad uncertainty stream, to the corresponding capricorn monad which is established initially as a condition. The establishment of the uncertainty monad, 'communication is do.not.know', operates initially as a condition for implementing the second stream in the fan of positive secondary streams. On the fulfillment of this condition, ESIE takes the user to the source of the second secondary stream. The uncertainty monad is a condition for proceeding to the monad at the top of the second positive secondary stream; it does not automatically establish the monad at the top of the second positive secondary rule. The inference engine will put further secondary stream monad questions to the user to establish the form of communication.

The user is asked to state whether or not further monads exist in order to remove the uncertainty about communication of an offer, if possible. The first of the further monads to be put to the user, are the antecedents in the second positive secondary stream which flows into the positive primary stream at the point of the monad about which the user was originally uncertain, namely, 'offercom is ok'. The consequence in the second secondary rule stream is the same as the antecedent monad in the primary stream about which the user is uncertain. If the user is doubtful about the communication of an offer, in general terms, subsequent secondary streams in the fan are more closely concerned with the evidence which would establish the communication of an offer. They determine whether or not the primary stream antecedent monad, 'offercom is ok', exists in the user's case. A wholly written offer is tried in the second secondary stream. If the first antecedent in the second positive secondary stream, 'wholly.written is yes', fails due to a negative response, then

the negative monad which is established operates as a condition to test the next secondary stream in the fan of secondary streams. Wholly oral is tried in the third secondary stream, wholly conduct in the fourth secondary stream, and so on. These facts will clarify whether or not an appropriate form of communication has been used in order to remove the uncertainty. To invoke the wholly oral alternative, the negative monad 'wholly.written is no' must be established. To invoke the wholly conduct alternative, the negative monad 'wholly oral is no' must be established, and so on. The alternatives are only available in a set order and, negation, not uncertainty, links them. If the primary stream antecedent monad is established, then the existence of the other mainstream antecedent monads will be pursued. If all the antecedent monads on the positive mainstream are satisfied, then a positive result is reported. There has been an all positive journey even though uncertain and negative monads may have been used as conditions to test various positive rules.

If there is uncertainty about whether the offer is wholly written and the user gives the input, 'do.not.know', then the uncertainty monad, 'wholly.written is do.not.know', is established as a condition to test the second negative rule in the knowledge base. To give the most cautious advice, it is assumed that further secondary streams will not remove this doubt. If ESIE could report all risks of invalidity and evaluate all doubts, then it might be safe to proceed through other secondary streams. The first negative rule will fail because the uncertainty monad, 'wholly written is do.not.know' could operate as an antecedent in the uncertainty rule which would flow down to establish offercom is ok.not.ok on the primary stream. Once one monad in a triad is established, either as a condition or an antecedent, the other two monads in the triad will not be tested. The system will not put a question to the user more than once. The user will only be asked questions to remove uncertainties if there are further positive streams to test, either upstream or as alternative positive streams. In the CLIMS Pilot system, once a mainstream monad fails, no further testing of positive rules will be carried out, since the positive result could not be given.

Generally, where there is no secondary or further positive stream to pursue an uncertainty, then the user will enter a terminal uncertainty stream which leads to a final uncertainty monad. From this uncertainty monad, in the CLIMS Pilot, one of two paths will follow. Firstly, if there are negative streams which remain to be tested, the system will proceed to test these streams. If there are no negative streams remaining to be tested, then the uncertainty stream will carry the user on to an uncertainty conclusion, either a total uncertainty at the capricorn outlet or a partial uncertainty at the south pole outlet. Uncertainty searches arise from positive streams and may either feed back into the positive river system, proceed to negative rules, or terminate in a jurisprudential uncertainty which, in the CLIMS Pilot, is 'RISK OF INVALIDITY'. Uncertainty monads, which are conditions for the operation of a positive or negative rule, may be linked as antecedents in an uncertainty rule with an uncertainty consequence. The rule will operate when certain conditions are satisfied. Negative monads which are conditions, may be similarly linked and ultimately produce a negative result.

The search strategy through the world of rivers, operates like a moon or satellite, receiving and beaming back information about the user's journey through the river system. Jurisprudentially, in the CLIMS Pilot, a legal answer, 'do.not.know', will establish an uncertainty monad in the southern hemisphere. The user then will proceed upstream if there is a further positive stream; processing of the positive rules will then continue. If there is no further positive stream, then the user will cross the equatorial plane, to any remaining negative streams in the northern hemisphere. The uncertainty monad is a condition for the application of these rules. If a negative rule is satisfied, then the user will be propelled to the negative result. Negative rules, which produce the result 'INVALID', are considered before a result of 'RISK OF INVALIDITY' can be given. If there is an invalidity, this is a more certain legal consequence than a risk of invalidity. If a negative journey can not be completed, then the user will loop back, across the equator, to the first primary stream uncertainty monad that was established. Following this recursive process, the uncertainty monad ceases to act as a condition, and becomes an established uncertainty antecedent. The

recursive process is a process condition for the operation of the uncertain monad as an antecedent. Then the user is propelled to the uncertain result, which may be visualized as the south pole, or, if an all uncertain journey through the river system is complete, the intersection of the equator and the tropic of capricorn.

A failure of the first antecedent monad in the positive mainstream due to a 'yea', or 'no' legal answer further upstream, would take the user out of the positive stream system to the corresponding negative monad on the mainstream of the negative river. In the CLIMS Pilot, this is a monad in a single antecedent rule, 'offercom is not.ok'; since the antecedent is satisfied, the user will be automatically taken to the north pole conclusion. Other inference engines might offer more varied negative journeys. The CLIMS Pilot does not offer the all negative journey, or the full range of negative multi- antecedent journeys; but an all uncertain journey or any uncertain multi-antecedent journey could occur.

The limitations of the ESIE system do not permit advice on all invalidities and risks of invalidity. If it did, all monads which are established would be reported, with their status as condition or antecedent, and the overall search might be reported. As positive or uncertain monads fail, negative antecedents and consequences would be established. The search would take the form of a zig-zagging between positive, negative and uncertain streams. The alternative possible zig-zagging represents the potential for combinatorial explosion in the system. This makes the potential search very dense in the spherical space, although the knowledge representation in the world of rivers is clear and constant. If knowledge is separated into static and dynamic knowledge, then the potential of combinatorial explosion, is converted to search power.

The order of rules in the CLIMS Pilot knowledge base ensure that ESIE will not propel the user to an uncertainty result until the search for an invalidity is complete. Once there is an uncertainty, with no further positive rules upstream, there is no point in re-entering the positive streams downstream, since the

positive consequence could never apply. However, as negative rules fail, re-entry downstream in the positive rule might be thought notionally to happen: failure of a negative antecedent may entail selection of a positive monad which is located on a positive stream. Thus if the first antecedent monad in the first positive primary stream has failed due to an uncertainty, then, the single antecedent in the second negative rule, 'expired is not.ok' is tested to its secondary streams. If it is the case that the user is not sure that there is an offer which is wholly written, but is sure that there is no offer which has expired, the second negative rule will fail, and the positive monad 'expired is ok' will be established. Since this positive monad can not operate as an antecedent, because the first two positive mainstream rules have failed, it is established only as a condition. The reentry to the equatorial plane is on the basis of establishing a positive monad as a condition (other conditions may still be required) for converting to antecedents any uncertain monads which have been established as conditions. There may be uncertainty links from these positive conditions to the uncertainty conditions. Legal knowledge is highly complex.

The distinction between antecedents in a rule and conditions for application of the rule itself, are not apparent in the CLIMS Pilot knowledge base. Conditions for the application of a rule appear in a knowledge base rule as if they were antecedents. Conditions can control the order in which rules will be applied. However, the rules must be ordered to determine the sequence of search for rules to test. Consider, for instance, the following rule:

```
if communication is do.not.know
and wholly.written is no
and partly.written is no
and wholly.oral is no
and partly.oral is no
and wholly.conduct is yes
and comprehend.conduct is yes
then offercom is ok
```

The first five monads are conditions for the application of the rule; the next two monads are antecedents for the operation of the consequence in the rule. The zig-zagging path in this rule can be followed from capricorn (first monad) to cancer (the next four monads) to equatorial plane (the last three monads). The location of a rule in the tributary model permits management of the legal information for the design of processing which is implicit in the knowledge base.

For the CLIMS Pilot, the antecedent monads on the negative and uncertain rivers are not always linked by the disjunction 'or', whereas the positive monads are always linked by the conjunction, 'and'; some river systems may have mixed links. An example of conjunctions in a negative rule, is the following negative rule, where the monad 'partly.written is yes' is a condition, and the antecedent monads, 'partly.oral is no' and 'partly.conduct is no', are both required for the consequence to operate:

```
if partly.written is yes
and partly.oral is no
and partly.conduct is no
then offercom is not ok
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A fan of positive rules which deal with the disjunction of alternative rules,, requires a corresponding fan of negative rules to deal with negative conjunction. The locations and connections of negative structures is dependent upon the nature of the positive structures. In the case of a fan of positive tributaries, the negation of a positive monad may lead to a negative monad which is a condition for the operation of an alternative positive rule; the same negative condition may become an antecedent in a negative rule. The rules in the knowledge base are designed according to the world of rivers graphic, but they are corrupted by the processing or journey instructions or directions.

Negative conditions are cumulative: a sufficient number of negative conditions will activate the negative rule: the negative conditions are converted to negative antecedents. The cumulative monads may be connected in a negative stream as antecedents in a

negative rule which has a negative consequence. For the purposes of search algorithms, notations on conditional monads may accompany the graphic.

Potential combinatorial explosion is inherent in legal knowledge irrespective of how it is simplified in a system. The world of rivers model confines the combinatorial explosion to alternative processing, rather than monad rearrangements. In the CLIMS Pilot, the combinatorial explosion is restricted by the limitations of the inference engine. As soon as an invalidity on the mainstream is found, the user enters a negative stream and is propelled to a negative result, INVALID. Although negative monads may be established as conditions for upstream searches, journeys are limited to one negative antecedent in the mainstream. Only where there is no invalidity will the user's uncertainty be activated to propel the user to the uncertainty result, 'RISK OF INVALIDITY'. Journeys may therefore include multiple uncertainty conditions but only one uncertainty antecedent. The set of uncertainty rules corresponding to the first two positive mainstreams are considered following the set of corresponding negative rules.

The combinatorial explosion due to the possible mixed positive-uncertain-negative journeys into the three dimensionality of uncertainty or negativity can be viewed as chaotic. However some order in this chaos is preserved through the stable all negative, all positive, all uncertain rivers. Although the journeys may create dense pathways in the three dimensional space, they are described by reference to stable points in the three rivers and the poles. CLIMS journeys end either at the intersection of the equator and the international date line, called the equatorial outlet, which is the only positive result outlet; at the intersection of the tropic of capricorn and the international date line, called the capricorn outlet, which is the only wholly uncertain result; or at one of the poles, called the s-pole outlet, which is a partially uncertain result, and the n-pole outlet, which is a partially negative result. The cancer outlet, which is the wholly uncertain result, might be used as a further stabilizing point in developing other systems.

A world with an equator plane and two tropic planes, is the essence of three-valued logic. The pole results may qualify three-valued logic with two additional values. The world of rivers paradigm is not confined to three planes. It may contain any number of planes to accommodate multi-dimensional logic. Fuzzy logic may be accommodated by a finite set of planes, each apportioned to a different range of certainty or uncertainty. Furthermore, a world may have more than one satellite, with each satellite representing a different search of the same knowledge. This is effectively a blackboard system.(100) The paradigm of a universe of worlds, each with different stable planes, and different numbers of satellites, may be used to accommodate related fields of knowledge. These worlds may be linked if it is necessary to link journeys in different worlds. Meteor searches may search universes.

The arrangement of monads, rules, and the direction of flow, in a river system are determined by jurisprudential meta-rules. These meta-rules determine the relationships between legal categories. Meta-rules also determine a search strategy. The three dimensional tributary structure or riometasystem is an indication of the complexity of legal reasoning which combines practical, ideal and formal reasoning processes. The structure has a systemic flow, the various courses of which are potential flow for a particular user. The questions in the jurisprudential system of the knowledge base operate as a communication system, or an interface between the abstract world of the riometasystem and the real world of the user. The user's flow through the riometasystem is determined by the answers given in response to the questions.

Uncertainties in legal knowledge may be understood in terms of meta-rules or design rules of the river system. Legal knowledge uncertainty is not the same as the factual uncertainty of the user in answering questions. Three forms of meta-uncertainty may exist: monad uncertainty, rule uncertainty and system uncertainty. Firstly, monad uncertainty may occur where it is not certain that a legal concept is established. This is monad fuzziness. A legal expert may be able to say with some degree of certainty whether or not the monad exists in law. The user might be advised of this estimate and its implications in the advice to the user. This is

not the same as the problem of the user in satisfying monads which are established but which are open-textured. Fuzzy monads should be distinguished from open-textured monads. An open-textured monad exists in law but does not clearly specify all the factual instances that will fall within its ambit. A system might advise a user on the uncertainties of open-textured terms to assist the user to decide whether or not the user's case falls within the term. If the user is not certain about the existence of certain matters in the user's case, but could give a degree of certainty about being able to prove these matters, then fuzzy logic might be employed to calculate the certainty qualifications of the advice, in this respect. Expert fuzziness is not the same as evidentiary fuzziness; nor is expert open-texture, the same as evidentiary fuzziness.

Secondly, rule uncertainty may arise where either, it is not certain that a rule exists, or, there are uncertainties about the correct antecedents, their correct order or connectives, or their correct consequences, in a rule. Thirdly, system uncertainty may exist because there is uncertainty about how the rules are connected. The meta-rule that a monad can only have one place in system, assists in locating rules. If a monad is given more than one place, design difficulties could arise comparable to the difficulties of developing natural language semantic processors. Finally, system uncertainty may also result where the rules are incomplete and cannot be completed by rational extensions. These uncertainties are due to uncertain meta-rules: a meta-rule may not exist, or it may exist but its application may be uncertain. Issues might also arise for meta-meta-rules and so on. Users might be advised of the implications of meta-rule uncertainties, according to fuzzy logic based on the experts estimates of certainty, or in some other way.

An area of incomplete rules and relational or meta-rule fuzziness was identified in the knowledge base and formulated as an inoperable rule. This rule is as follows:

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if reason is unknown
and particularise is yes
then request is ok1
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This inoperable rule suggests that if the user is not certain that a reasonable person in the offeree's position would assume that an offer had been made, but the offeree had made a request for further details of the offer, then the request monad in the first positive mainstream rule would be satisfied. The request for further details might over-ride the uncertainty result of the monad, 'reason is do.not.know'. However, if it is not the case that a reasonable person would assume that an offer had been made, then there would not be an offer; so how can a request for details of an offer be made if there is no offer? Further exploration of this jurisprudential complexity could be pursued. However, the purpose of this thesis is to simply lay a foundation for the development of a science of legal choice, not to comprehensively develop it.

If the various possible combinations of meta-rules are to be considered, this raises the problem of combinatorial explosion in the meta-rule levels of legal choice. Combinatorial explosions in legal knowledge may be controlled by the division of the knowledge into system rules and layers of meta-rules. The tolerable level of complexity may be stabilized by the level at which the system rules are set. The extent of the investigation of a case by a system will then be determined by the level of the system rules, which is searched or explained. The potential infinity of investigative levels makes any ad hoc limit to some levels, another form of system uncertainty.

The river structure assists in demonstrating the complexity of legal knowledge and its application. It might be expected that a complex and meticulous metaphysical structure would have been developed in order to connect, theoretically, the multitudinous contractual disputes which have been before the courts. The world of rivers paradigm, on the one hand assists an understanding of the knowledge so that a program can be designed, and on the other hand, assists an understanding of how the program works. The sort of shell which is needed to automate law is one suited to building and processing a massive three dimensional river system. Colour coding for positive, negative and uncertain elements in the graphic might assist in formulation and maintenance of the knowledge mapping. Such a graphic should be available in a TECLAW

system to assist a legal knowledge engineer with the construction of a legal expert system, and to show an interested user, the basis for possible paths through a legal transaction.

The three-dimensional tributary graphic may suggest ways in which mathematics might be used in legal knowledge engineering. This possibility calls to mind the notion of a generalised mathematics which Leibniz (1646-1716) called *Characteristica Universalis*. By this means he hoped to simplify the resolution of philosophical conflict. As discussed in Chapter Five, Leibniz also posed a philosophy of monads and invented the first calculating machine. The world of rivers paradigm is a synthesis of many earlier paradigms of human intelligence, including Whewell's river paradigm and astronomical paradigms.

In summary, the first Pilot demonstrates that rules of law can be automated by a simple backward chaining device; it is a pilot in the jurisprudential sense because it is a small sample of how a fully developed contract expert system might work. The system automates journeys through a jurisprudential riometasystem. It processes a small sample of production rules to discover if there are invalidities, uncertainties, or no invalidities found in a contractual transaction. The Pilot demonstrates that, in order to automate the rules of contract law, the rules must be expressed in an appropriate form as data structures. The knowledge base was constructed by reference to the logic graphic of a world of rivers or riometasystem. In a riometasystem, the arrangement of the rules of law is the form of their legal logic. They are arranged as interlinked rivers. The hierarchy of tributaries preserves the basic structure of legal knowledge, that of principle-rule-paradigm case. The meaning of the rules of law, in relation to each other, indicates the relative position of the rule and its directional flow in the world of rivers representation of the knowledge. This design of three dimensional, directional logic in substantive law is a major finding of the CLIMS Pilot experiment. The riometasystem also may be a useful paradigm in dealing with the representation of complex knowledge in areas of expertise other than the law.

A more extensive shell than ESIE, in terms of types and capacity of processing, would be required to build a complete contract expert system. The pilot automates probably less than 1% of the total volume of contract law. The pilot may be regarded as a prototype insofar as the structure of the knowledge base is designed in accordance with an original structure of theoretical knowledge and transactional heuristics.

iv. Testing and Evaluation

When the knowledge base was prepared to the stage indicated in Appendix A, the system was run through several hypothetical cases, and performed consistent with an expert's opinion. No other test was devised. After the limited testing of the CLIMS Pilot, it was concluded that the knowledge base contained automatable law and could be described as a jurisprudential geometasystem: the knowledge was of a jurisprudential nature, arranged as a metasystem and operable in the hardware environment.

Due to the limited testing, all of the processing implications of the knowledge base were not fully elicited. More formal testing procedures would be required for an experiment where the aim was to provide a reliable advisory system or reliable task performance. Tests might be devised to ensure that all aspects of the logic were in proper working order. The potential for combinatorial explosion might limit exhaustive testing of a system. It would be impracticable to test all hypothetical cases. Random testing of the logic might be used.

The testing, as well as the operation of a system, may be understood and designed by reference to the riometasystem model. Relevant concepts and rules of law might be selected for testing by reference to the facts of real or possible cases, or by the rigour of alternative hypothetical cases, given alternative combinations of monads. The concepts and rules of law usually contain general and sometimes abstract terms. It is sometimes difficult to design questions to establish the existence of something in general or abstract terms. Testing of the suitability of questions might also be required in regard to the communication style and circumstances of various users. If there

were an empirical investigation of users' communication style by way of preparation for the construction of the system, testing might be required to vindicate the selection or drafting of questions. A shell should have a facility to permit the user to report unsatisfactory aspects of the system so that authors could monitor and improve the system.

Unless the author of a legal expert system explains the jurisprudential basis of the system, it can be difficult to detect, *ex facie*, the nature of the jurisprudential system in a legal expert system. The validity of a legal expert system may be considered through testing the system in various cases. A jurisprudential system may be used as the testing model, even though it was not used as the design model. Thus a contract expert system which was designed on some basis other than a riometasystem could be tested by running the system and checking the results against the riometasystem model. It is a task of a legal knowledge engineer to ascertain how legal knowledge, reasoning, heuristics and other aspects of legal expertise have been represented in a system and whether or not there is a valid representation and processing.

The first Pilot might be further evaluated and adjusted on the basis that it did not represent the best legal opinion. Unless a legal expert system were adopted or produced by a law-making authority, that is, by the judiciary or parliament, it can only amount to an opinion about law. The CLIMS Pilot knowledge base contains automatable law in the sense of an expert opinion of what the legal knowledge is. In the future, legal expert systems might be developed under the auspices of parliament or the judiciary. Interesting political issues might arise as a result. If the judiciary play no role in the development of legal expert systems, then the judiciary might decline in importance in the legal system. Conversely, if the judiciary do participate in the development of legal expert systems, then systems which are founded on the best legal opinions as well as law-making authority, might be produced. The judicial system might then be suited to a high tech age.

In a judicial consideration of a case, selected law must be applied to determine whether there is a clear legal consequence, or, a need to develop or modify the law to achieve a resolution of the conflict or potential conflicts concerning the events and objects in a particular case. Judicial modification of the law may be required. There is a recursive structure in judicial methodology: the law is reconsidered in each case before the court. This may amount to either a cyclic repetitive application of the law, or a spiralling modification and expansion of the law. An expansion or modification of the riometasystem may be the model for a judicial facility in a legal expert system. Judicial recursion is an instrument of judicial testing. A judicial facility might provide both maintenance and testing of a system.

v. Ethical Implications

It may be noted that the positive and negative rivers of the tributary model, are not equal to good and bad respectively. In contract law, it is lawful to have a negative goal. A person wishing to avoid a contractual obligation may target a monad or tributary which leads to a negative consequence.

vi. Use of the First Pilot

The first CLIMS Pilot is so limited that it is of very little practical use as an advisory package. However, it provides a jurisprudential prototype for automating legal theory of the common law and legislation. In particular it provides an indication of the structure of legal knowledge as a guide in the development of both larger jurisprudential systems, and a computer environment for legal knowledge. The first CLIMS Pilot was presented at the 4th International Computers and Law Congress, in Rome in 1988.

b. The CLIMS Pilot No.2 Experiment

In 1989, at Cambridge in England, CLIMS Pilot No.2 was constructed by the author and Tim Flannagan of the British company, Machine Intelligence Ltd. CLIMS Pilot No.2 was designed on the basis of the first CLIMS Pilot. The main purpose of the second experiment

was to construct a prototype shell suited to the world of rivers paradigm. A logic language, Prolog, was used. The processor which was developed, offers the user a choice of three inference engines and a greater choice of journeys through the riometasystem. The system of inference engines, represents three different, but related forms of legal reasoning.

Inference Engine No.1, like ESIE, stops as soon as the user's case establishes a negative conclusion, and reports this conclusion. If there is no invalidity, the system will complete the processing and report either a risk of invalidity or no invalidity found. Inference Engine No.2 stops as soon as a negative conclusion is reached and it reports both the invalidity and all risks of invalidity which may have been established before the negative conclusion was reached; if no invalidity is found, all risks of invalidity or a positive conclusion are given. Finally, Inference Engine No.3 reports either a positive conclusion, or, all invalidities and risks of invalidity which the user's situation contains. In addition to reporting conclusions, CLIMS Pilot No.2 gives reasons for its conclusions. These reasons are user-friendly statements in terms of the mainstream monads. Explanations higher in the riometasystem were not developed. However, the explanations that were developed established that semantic processing is implicit in the processing of data structures. Explanations as to why a question is being asked could also be developed by reference to the data structures as an improvement on the ESIE trace. The second pilot facilities are a considerable advance on the ESIE system. The first CLIMS Pilot carries out only one form of processing but the rules are arranged in an order so that complete processing of two of the three stable rivers, namely the positive and uncertain rivers, is possible: the system will find a positive result as soon as possible, failing which it will report a negative conclusion or, if no negative conclusion applies, then the uncertainty conclusion. The ESIE trace function is only as friendly as the limited rule syntax will permit. The trace information is not presented as reasons for a conclusion.

CLIMS Pilot No.2 has other enhancements. The user can elect to gain access to the current state of conclusions and reasons at any

stage of the consultation. Any consultation can be saved and printed out. There is greater opportunity for interaction between the user and the system. The user interface in both pilot systems proceeds, basically, by a series of output questions and input answers. However, the second pilot has a more elaborate and flexible interface. It allows a user to go back and change answers at any time, and to undo these changes. Unlike the first CLIMS Pilot which runs on any MS/PC DOS computer, CLIMS Pilot No.2 runs on any Apple Macintosh and is almost entirely mouse driven with icons and windows. CLIMS Pilot No.2 was demonstrated at the 2nd Artificial Intelligence and Law Conference at Vancouver in 1989.

c. The CLIMS Database Experiments

The development of forty-two CLIMS Databases was undertaken in 1989, respectively by forty-two business law students at Charles Sturt University - Mitchell. The databases were constructed using the public domain package, PC-File. On the basis of a common system design prepared by the author, the students implemented an information network in forty-two various individual ways. The database project was guided by an earlier student project in business law, under the direction of the author, namely, LAWBASE, a computer aid for a law exam (CALE). LAWBASE was used by its authors, Carl Jackson et ors, for their open book law exam in 1986. It was built as a PC-File system of case records. In subsequent years it was developed by other students who used their improved versions in the law exam. LAWBASE was demonstrated at a Computer and Law workshop at the Law Faculty, Monash University, in 1986.

The CLIMS databases went beyond case records. They are contract law information systems, employing secondary source and heuristic legal knowledge as well as case summaries. The database system has four search fields in each record: Address, Heading, Menu and Information. The records in the database were semantically linked through the menu field. The network is a series of tree structures representing the decision trees in a contractual transaction. These tree dimensions take the form of a spiral of trees. The tree commences with the choice of exploring one of two alternative ways of commencing a contractual transaction: a

non-binding form of negotiation, or a binding form of negotiation. Following a selection, the next choice is given of exploring one of the categories of the selected negotiation form: the non-binding forms are enquiry and invitation to treat, and the binding forms are inducement to contract and offer. A third form of negotiation might have been added, namely, the legally uncertain form. People do use uncertain forms of negotiation when their communications do not fall clearly into the specified non-binding and binding forms. The particularisation of negotiation forms was followed through to case examples or authorities.

At the conclusion of the commencement tree, the user is advised on the forms of communication that may be used, namely writing, oral, and conduct; this information also spreads out as a tree. Then the system proceeds through the alternative ways of continuing and concluding negotiations, alternative performance requirements, and alternative ways of discharging a contract; each of these stages in the contractual transaction constitutes an information tree. A module explaining the choices concerning consideration was developed separately as a preliminary tree. Before a contract is possible, the requirements for consideration must be met. A module on remedies was also developed as a supplementary tree. The design of the database used a mainstream of root nodes, from each of which the user could explore upstream a greater particularization of the knowledge. The network is an information system but, through its inter-related menus, it simulates, to some extent, the intelligence of forward and backward chaining. In each record which the user inspects, there is a menu which indicates which records are relevant for further pursuit of various particular lines of investigation.

The design of the CLIMS database network was developed by the author to extend the jurisprudential analysis of contract law for further pilot projects. In particular, it assists in reconciling tree structures in contract knowledge and the world of rivers paradigm. The semantic linking of tree structures in the database amounted to the journeys through the world of rivers. A river can be rearranged as a single tree if the antecedents on the mainstream are treated as the first generation of children and the

mainstream consequence as the root node. The genus-species hierarchy is emphasised in a tree paradigm, whereas the flow of legal reasoning and interim consequences are emphasised in the river model. Trees rather than rivers may be set into spherical cross-sections and pinned by triad and inter-triad links. Perhaps the metaphor of roots of a tree more comfortably fills the earth paradigm. However, a river paradigm suggests the search strategies more vividly. In either case, a reasoning system or a system of explanation of the law could be designed. The mainstream consequence of the database system was the conclusion of the transaction, which carried its own tree of information.

The CLIMS world of rivers which was used in the design of the database trees, was a more developed form of contract knowledge than had been used in the first two pilot experiments. It employed the heuristics of a transactional approach, traditional theory, and case summaries. Traditional theory uses some transactional chronology in its framework. However, the database system was not given goal directions. The user could search for contract knowledge but the knowledge would have to be interpreted to suit the user's purpose. In the database system, the networking through the menu field reflects semantic intelligence in the system, but the processing, which is a search instigated by the intelligent decisions of the user, is not machine initiated intelligence. The nature of the user interface must be considered in determining whether or not human intelligence is simulated artificially. Artificial intelligence must be able to communicate its intelligent processing.

Goal orientation in the CLIMS database could be achieved with further development of the world of rivers design aid. A minimax contract system was posed by Antonio Martino in the following comments:

In automated legal decision-making systems (or aids to legal decision-making), it is possible to model: a) the reasoning behind a judge's decision; b) the values taken into consideration by a legislator in enacting a law; c) a lawyer's arguments in support of his case; d) the criteria for evaluating evidence; e) the relative positions and optimal manoeuvres of two or more parties to

a contract; and f) the logical premises for evaluating how to organize systematically the raw material known as a "set of laws", etc....(101)

Anyone called on to interpret the law who is aware of all the possible consequences of each interpretation has a greater range of choice in his decision-making.(102)

An understanding of the range of choices in a contractual transaction is necessary for the construction of a minimax goal system. The riometasystem paradigm may be used to represent the minimax knowledge of contract law. There might be a trilogy of rivers: minimax (positive), non-minimax (negative) and uncertain. A minimax contractual path would optimize the benefits received by a party to the contract. The contractual goal is to minimize risks and losses and maximize gains. The minimax model could be extended to incorporate minimax management of conflict resolution as well as minimax management of conflict prevention. A failure to maintain a journey through the positive river would lead to a non-minimax or uncertain contractual transaction. Data could be designed by reference to the trilogy of goals. For instance for the commencement of a contractual transaction, the initial choice would be minimax, non-minimax, or uncertain form of negotiation. Any of an enquiry, an invitation to treat, an inducement, or an offer might be consistent with a minimax path, provided certain care is taken in the negotiation. The user can be advised on the sort of care required for each form of commencement. So, for example, it would not be appropriate to commence with an enquiry if this would unduly delay the transaction. If the initiating party is able to formulate a minimax offer at the outset, then a minimax offer or a minimax invitation to treat may be more appropriate than a non-minimax enquiry. The system could advise fully on the advantages and disadvantages of each choice. The mainstream may have islands; for example, it may be possible to commence with both a minimax inducement and a minimax invitation to treat, or with either. A thorough analysis of contract law is required to frame advice suited to the goals. This minimax system is being developed for further CLIMS Pilots.

Further Exploratory Work

Following the jurisprudential design of the first Pilot, in 1988 the author and Robert Rouse, an expert in company law, developed a system, COCO 129, to automate section 129 of the Companies Code, using ESIE. This section regulates the freedom of a company to purchase its own shares. The riometasystem logic proved to be a suitable form of knowledge representation for this legislation as well as the common law of contract. However, it became apparent that a great number of system rules was necessary to spell out the alternatives in a compactly worded section of an act. It was clear that ESIE was an unsuitable shell, and the system was not completed.

The first two CLIMS Pilot experiments revealed the extent of the task of developing a rule-based system which would both carry out the legal reasoning of a lawyer and explain the law. It became apparent that the data which would explain the law could be linked by rules which were not so much rules of law as rules of the sequence of explanation of law. If a user is concerned with learning the law, or learning what to do or how to behave according to law in order to optimize personal benefits from commerce or society, then a system which simply processes the user's factual situation, is not as appropriate as a system which guides learning and reflects the dimensions of the knowledge, and the dimensions of social interaction and social organisation.

CLIMS Pilot No.3 was also constructed at Charles Sturt University - Mitchell, by the author and technical advisor, Sue Gates, using the Texas Instruments Ltd shell system, Procedural Consultant and PC Plus. In this experiment, the jurisprudential dimensions of the knowledge are explored, within the framework of a large, robust, flexible shell, with networking facilities superimposed on a rule processor. Procedural Consultant provides a tree graphic guide for building the system. PC Plus will build system rules from the tree information. CLIMS Pilot No.3 is based on a design which explains contract law by reference to minimax goals.

In the development of the CLIM Minimax System, it was discovered that a boundary logic was required for the jurisprudential system,

by way of introduction to the system. Von Bertalanffy observed that all systems have boundaries, and that all boundaries are ultimately dynamic.(103) Jurisprudential systems appear to be no exception. CLIMS Pilot No.3 contains a sample of the boundary logic, which can be processed, according to the legal choices which it contains. The boundary logic advises, inter alia, that the system is designed for business users, and advises on the minimax path through contractual transactions, that is, the path which will minimize risks and losses and maximize gains. The system goals are explained in terms of management goals. The user is advised that there are legal choice sets throughout a contractual transaction, and jurisprudential and practical consequences of the minimax, non-minimax and uncertain alternatives in each set. The boundary logic also deals with time and role stabilizations of the user interface, and any assumptions that are made by the system. The jurisprudential material in the boundary logic lays the basis for a more complex and extensive system than the sample of rules used in the first two pilots. Because the nodes of the Procedural Consultant tree allow for extensive chunks of data, elaborate legal knowledge engineering instructions are required in the map of the riometasystem. Triad choices and fan choices could be accommodated in the nodes. For highly complex and extensive systems it may be necessary to construct an information system as a basis for designing a communication system. This is especially so if the system to be constructed is to provide information about the law as well as processing the user's case. Information-communication hybrids may be designed as comprehensive, intelligent, learning packages.

The CLIMS Project has addressed the problem of finding legal intelligence paradigms in legal information and legal communication systems. It has also explored jurisprudential systems in contract law with a view to constructing specific automatable systems for various purposes. Overall, the CLIMS Project has proceeded by incremental co-development of the major contract system, the TECLAW system, and legal knowledge engineering methodology. Planning of the course of the Project is constrained by available resources.

Requirements for TECLAW (Total Environment for the Computerization
of LAW)

A TECLAW system will require more than a rule processor. In order to deal with all the dimensions of legal choice, a wide range of facilities is required. An outline of these may be viewed as follows:

1. A reasoning tool
2. An explanation tool which may be linked to the reasoning tool
3. A search function
4. An arithmetic calculator
5. A document modeller
6. A graphics tool
7. A game tool
8. A cartoon tool
9. A critical path tool
10. A probability tool
11. A judicial reasoning tool
12. An equity tool for special specific modifications of the system
13. A feedback recorder, so that the user may send suggestions for improvement and other information back to the authors
14. Menu access

15. Hypertext facility

16. A database retrieval system

An environment which offers all these facilities and perhaps more, would be a rich source of intelligence. The system should be designed so that, even though it is a highly complex device, both the user who is constructing specific legal services, and the user who is enjoying those services, should find it easy to use. The nature of computer technology requires collaborative development. The first chapter in the text, Computer Applications in the Law, by P.B. Maggs and J.A. Sprowl, published in 1987, is entitled, A Sociological Introduction to the Use of Computers in the Practice of Law; this chapter points out the collective nature of artificial intelligence.

The stratified nature of modern computers, and the number and thickness of the individual layers that form their structure, reflect the limited ability of the human mind to cope with complexity. No one individual possesses sufficient expertise and has sufficient time to construct a modern computer in its entirety. Groups of individuals having divergent backgrounds and talents must participate in a joint design effort, with each group contributing one layer to the final product.

...When viewed from a sociological perspective, viewed as if the group that designed each layer were personally performing the functions carried out by the layer they designed, a computer resembles a large corporation far more than it resembles an automobile. The "user" of the computer sits in the president's chair and gives brief, succinct orders to the top layer of management. Each succinct order is expanded into more and more highly detailed orders by the layers of management below until ultimately thousands of workers the "user" president never sees, who may speak an entirely different language than the "user" president, perform the tens of thousands of orders that enable them collectively to carry out the succinct orders issued by the "user" president.(104)

Legal knowledge engineering adds to the layers of expertise needed for the construction of a legal expert system. Small experimental legal expert systems may be built by one or two people with computer and legal skills. However, large commercial systems are

likely to require a team of experts. At least one domain expert with specialised legal knowledge would be essential. A pooling of the best specialised legal expertise might produce the best system. Where a team is required, methodology may be modified to suit the collaboration.

A team requires some common paradigms in order to produce a system. These paradigms should allow maximum scope for invention and finding solutions to problems. A computer is sometimes viewed as a black box. Ostensibly, to the user, what appears to be happening is that the monitor provides output, and requires input to generate further output. The black box receives input like stimuli and responds with output. In the black box there are mechanisms which process the input and select or decide upon the output by way of response. The black box is analogous to human conscious and unconscious thinking processes which receive stimuli and select responses. Basically, the legal knowledge engineer determines the nature of the input and the output, which is known as the user interface, and designs the statics and dynamics of the processing system so that the user can drive the program or carry on a conversation with the machine. The machinery is the artificial robe of a legal intelligence which might be a collective consciousness of the best specialist lawyers, communications specialists and computer scientists.

Fundamentally, modern computers are instruments of data storage and data processing. Computer software consists of programs which direct the storage, processing and retrieval of data. The relationship between data processing and expert systems is explained by J.L. Alty and M.J. Coombs as follows:

Expert systems have their origins in traditional data processing. They are the result of continuous attempts to improve and extend the automation of some aspects of human information processing. In order to accomplish this task we need to represent in a computer system the nature of the data and processes involved.

... A digital computer transforms an input sequence into an output sequence.
... we have to define a representation

which enables us to inform the computer of the correct set of transformations required (i.e. the program).(105)

Computers can store and process legal data in two ways. Firstly, information may be stored and retrieved through a legal information retrieval system. This simulates human memory and recall which is a facet of human intelligence. Legal information retrieval systems recognise relevant data by a search function which identifies the nominated byte patterns. This search function is not an intelligent processing of the knowledge or meaning in the data. Simple information retrieval systems perform the task of memory and recall of input. Advanced database systems, such as relational databases and networks, simulate cross-referencing, and may provide a bridge between simple retrieval of input and intelligent systems. Alty and Coombs put it this way:

Database systems are an attempt to define a higher level representation of the logical connections between data. The relational and network approaches are simply different attempts at solving these problems.(106)

Secondly, the process of retrieval may emulate legal reasoning, the heuristics of legal practice, or some other aspect of legal expertise; this form of storage and processing of data is artificial legal intelligence. Masoud Yazdani summarizes the difference simply. He says that programs have been viewed traditionally as procedure and data. However, expert systems contain three distinct modules: (i) the facts about a particular case, (ii) rules in the domain of expertise, and (iii) rules for processing the rules of the domain of expertise.(107) Nevertheless, the three modules are mostly conceptual and in practice would constitute a single database. Roy Rada explains the modules in relation to problem-solving as follows:

Problem-solving can be viewed as searching. One common way to deal with search uses rules, data, and control. The rules operate on the data, and the control operates on the rules. ... the control decides what rule to apply and when.(108)

Modules are designed as the architecture of the expert system and are certainly essential considerations in a reliable system. According to Yazdani, the three modules amount to three kinds of knowledge:

- i. Factual or declarative knowledge - the facts of the user's case gathered from a dialogue with the user; commonly known as the data.
- ii. Procedural knowledge - a form of reasoning about the facts derived from an expert; commonly expressed as production rules.
- iii. Control knowledge - the method of applying the procedural knowledge to the factual knowledge; commonly constructed as an inference engine.(109)

Prima facie, the law is data in the nature of knowledge: it must be understood to be applied correctly. The patterns, structures and processes in legal knowledge must be represented and modelled in the computer microcosm as storage, processing and retrieval of legal data. Legal reasoning is potentially both data and data processing. However, it is not a trivial task to design an architecture for the legal domain, because of the complexity and density of legal knowledge. Roy Rada explains the difficulty as follows:

Domain expertise, in fields such as medicine and law, cannot currently be easily entered into the computer... Medical students are given large amounts of information in the first two years of their training. In the ensuing years these students are expected to learn how to structure and use this information by observing more experienced practitioners. Formal instruction in problem-solving methodologies has not been common, in part because of a limited ability to describe such methodologies. The creation of computerized medical expert systems has tended to require explicit entry by a physician of rules for solving problems. The science of how to do this is little developed. The way one person creates these rules tends to vary so much from the way that another person would create the rules that extension of a computerized expert system by other than its creator is uncommon.(110)

Yazdani sets out the characteristics of a difficult domain, and all these characteristics apply to the legal domain. These characteristics are as follows:

- i. The experts do not generally agree.
- ii. The strategies in reasoning are complicated.
- iii. The knowledge includes spatial and/or temporal relationships.
- iv. The problems take a long time to be solved by people.
- v. A lot of actions hinge on a lot of conditions.
- vi. There are too many objects and too much reliance on commonsense concepts.(111)

A difficult domain emphasises the general problem of creating artificial intelligence: the mind is vast, complex, multi-dimensional, and communicated through narrow outlets. Choice is a major paradigm in the structure and processes of the mind. This was pointed out by Waldrop in reference to the first thinking machine, Logic Theorist.

Consider, for example, that life is largely a matter of making choices - which is just another way of saying that almost every cognitive act is a form of problem-solving. We've already seen what that takes. Even in a domain as straight forward and as well defined as symbolic logic, the array of choices that Logic Theorist faced was vast beyond imagining; it had to use heuristics, uncertain rules of thumb, to find its way. And the uncertainties only get worse out in the real world, where things are never straightforward and well defined....

There is too much data pouring in, too many choices to be made, too many gaps to be filled, too much that is unexpected, ambiguous and unknowable.(112)

Knowledge structures are to be distinguished from data structures. In computer science, categories of data structures, such as rules, have been fashioned to indicate the sort of processing in a program and the forms of representation of knowledge. A representation of knowledge amounts to a syntactic and semantic system in the knowledge. Legal knowledge may be represented in various ways and the problem in developing a TECLAW system is to decide which are the best forms and what range of forms should be made available. Forsyth suggests that there is a constancy of meaning in knowledge in the various forms of representing it; he makes the following observation:

At some very deep level all kinds of knowledge representation must be equivalent, but they are not all equally convenient. When in doubt, the best plan is to choose the simplest you can get away with.(113)

Certainly, all computer-based representations can be reduced to the same form of representation, namely the use of bits as symbols. The interchangeability of frames, semantic nets, trees, Horn clauses, and rules has been demonstrated in the field of artificial intelligence.(114) The CLIMS Project experiments demonstrate that a riometasystem can be converted to production rules, to trees, and to the Horn clauses of Prolog. However, a common form in different symbolic representations does not mean that the semantic content in each form of representation is the same. Each symbolic view may present different aspects of the semantic content of the knowledge. Then these aspects may be presented to the user in various ways, depending upon the user interface. A representation must contain both the expert knowledge and the structures for processing it in a way that will provide the expert advice which is required.

According to Winston, knowledge representation is the key to creating artificial intelligence.(115) Winston maintains that intelligent behaviour can be displayed along several dimensions. He provides a framework for the evaluation of AI program which might be used to shape methodology.(116)

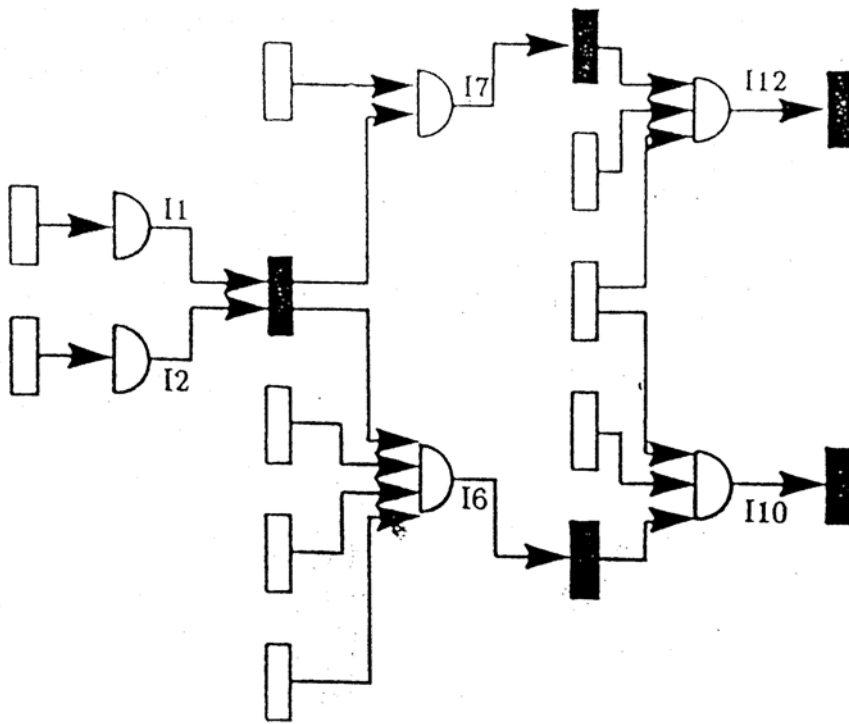
. Is the task clearly defined ?

- . Is there an implemented procedure performing the defined task ? If not, much difficulty may be lying under a rug somewhere.
- . Is there a set of identifiable regularities or constraints from which the implemented procedure gets its power ? If not, the procedure may be an ad hoc toy, capable perhaps of superficially impressive performance on carefully selected examples, but incapable of deeply impressive performance and incapable of revealing any principles.

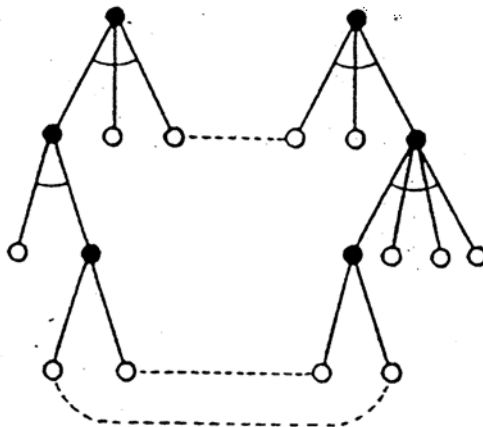
A design aid such as the riometasystem which provides jurisprudential control over the drafting of knowledge structures and selection of processes, should conform to all these requirements. A design aid which does not provide adequate jurisprudential control is likely to lack some of these requirements.

Winston further suggests that if a problem is hard when expressed in one representation, then an alternative form of representation should be tried.(117) He demonstrates the alternative forms of representing the same knowledge diagrammatically. His illustrations are set out in Figure 10.(118) He also suggests that by analyzing the way that one state of knowledge transforms into another, inferences can be made about the processes in the changes. Accordingly, established problem-solving paradigms may be modified to better represent the knowledge and processes of finding solutions. Various paradigms of human intelligence may be used in the design of legal expert systems, particularly in the representation of knowledge. Choice may be represented in jurisprudential algorithms, lists of alternatives and consequences, procedural flowcharts, inference nets, frame structures, or trees. Decision trees branch according to the input or legal answers, and the course for establishing factors. Winston describes decision trees as follows:

A decision tree is used rather like a pinball machine: unknowns are dropped into the tree at the top; the various tests deflect them one way or another; and they drop out at the bottom at places associated with various identification conclusions.(119)



An example illustrating how antecedent-consequent rules tie facts together into an inference net. Open rectangles represent raw facts; solid rectangles represent deducible facts. The rules are those of the animal-identification system.



An inference net drawn to make explicit the AND/OR tree implied by collections of antecedent-consequent rules. Each AND collection of branches corresponds to an antecedent-consequent rule. Open circles represent raw facts; solid circles represent deducible facts. Raw facts used to reach more than one conclusion are represented by separate instances (here indicated by dotted lines joining the separate instances). This tree was made from the inference net in the last figure, figure 6-10.

Figure 10 Winston's Alternative Knowledge Representation

In the case of a three valued logic, yes, no, or do not know, there will be three branches for each node, except terminal nodes. Trees may represent legal choice in different ways. Lennart Aqvist has developed game trees in relation to the law.(120) Deduction may pre-empt or assist in the representation of legal choice decision-making. For instance, the deductive process in the rule paradigm occurs when the user establishes the antecedent(s), and the consequence necessarily applies. The legal propositions contained in a rule are treated as a priori on the basis of law-making authority. It could also be said that the application of the rules is valid, a fortiori, by virtue of its simulation of judicial or expert practice and power. Formal and deontic logic may provide notational representations for legal choice.

Such paradigms are useful in the organisation of data, and in the formulation of the jurisprudential systems and jurisprudential geometasystems. The jurisprudential metamorphosis from data to geometasystem may require the use of a different knowledge structure at each stage of constructing a legal expert system, from raw expert knowledge to the user interface. The meaning in the law is viewed differently at each stage. The importance of knowledge representation in an expert system is stated simply by Roy Rada.

The proper representation of this knowledge is critical to the success of an AI program.(121)

Metaphysical structures in legal expertise can be used as design aids or cognitive maps of legal knowledge, so that conceptual, jurisprudential and legal relativity may be managed to produce correct meaning, correct processing, and correct communication during the provision of the automated legal service. A legal knowledge engineer who has to acquire expertise from specialist practitioners must initially stabilize the different perspectives of the specialists; the relative views of various specialists is a matter of jurisprudential relativity. Legal knowledge in the English legal system is expressed in many different ways. It does not have the regularity of the Hammurabi Code, the rules of which are stated in if...then formulae. However, it could be converted to some regularity so that it might be more clearly seen and

automated. Then the different forms of knowledge representation and programs, which can accommodate regularity in different ways, may provide for social diversity in the law. Correspondingly, different computer languages might be configured to work in parallel or in a coherent sequence, to increase the flexibility of a system. Parallel procedures must have an overall coherence: they are the basis of blackboard expert systems.

Some jurists have considered the design of a comprehensive computational environment for law. In 1984 at the First Annual Conference on Law and Technology at the University of Houston, Michael Heather of Newcastle-upon-Tyne Polytechnic, posed an architecture for a Half-Intelligent System, based on the decision-making procedure and pragmatics of a lawyer.(122) At the 1985 Florence Conference, he considered the richness of the current design of the Japanese Fifth Generation Computer System, and suggested that computer scientists would need to develop a very rich system to deal with the complexity of legal knowledge.(123)

The integration of object-oriented processing and Prolog inferencing has been explored by Thomas F. Gordon with a proposal for a system, OBLOG (OBject-oriented LOGic), which is a front end to predicate logic, and treats objects as a variant of logic sentences. This effectively amalgamates predicate logic and frames, while preserving the best features of frames and Horn clause logic.(124) The LEX Project in Germany, a joint project between IBM Scientific Centre and the University of Tuebingen, aims to build a system with a natural legal language front end, a knowledge processor and a legal query system. Finding semantic equivalence is the key to transformations from one knowledge representation to another; but the representation of knowledge in some computational form must first be established. Only then can the search algorithms and the control strategies be settled.

However, as Winston points out, there must be a proper balance between the development of a complex processor and the development of knowledge representation.(125) A set of control options, or a control structure, which provides choices of processing within a system of processes, both presupposes and determines the knowledge

structures in an intelligent program. Adjustment of knowledge representation may require adjustment of processing and vice versa. Control choices amount to problem-solving paradigms. They may require homogeneity in the knowledge representation, or they may co-ordinate a variety of different forms of knowledge representation, each of which adds to the advice for the user.

Human communication depends upon a common method of communication, but individuals have developed their own nuances in their use of a common language. The problems of unravelling and using the time-space synthesis of human language in the expression of law, also presents problems. Often the efficiency of human communication can not be programmed in digital languages without a serious risk of misinterpretation. The environment of the machine program does not have the same sensitivity to communication of human meaning, as the human environment. Further, sometimes when the space-time meaning in law is unravelled, logical incompleteness becomes apparent. Paradoxes and social policy implications may also be more transparent. Within the system of human interaction which the law has created, the law may be viewed differently at different points in the system. Processing of the knowledge differs according to the knowledge structure and the perspectives used. However, there is a constancy in the jurisprudential meaning despite the different structures and different views by which it is represented.

Once legal knowledge has been stabilized, then it must be subjected to appropriate jurisprudential systems analysis before it can be cast as a legal expert system. Deep models of legal knowledge are required to accommodate the multi-perspectives of a relative world, viewed with a limited human understanding, and to accommodate the relativity of human understanding. Without deep models, there is considerable difficulty in designing systems which will process and communicate extensive and complex knowledge, such as the knowledge in legal expertise.

A system of monads assists in representing the relativity of the real world in its condensed forms. The world of rivers paradigm has been posed as a deep model of legal knowledge. The riometasystem provides a model for any synthesis of different

forms of legal knowledge, from heuristic rules to the meta-rules of legal theory. Rules to explain 'what if the law were otherwise' might also be developed through the riometasystem design aid. The riometasystem might be processed by various interacting inference engines which will use input, in various ways, in relation to the information in the various rivers, to generate further output.

A TECLAW system should provide for choice processing, data processing and dialog processing. A considerable amount of work remains to be done to produce a standard legal knowledge processor. An important feature of a TECLAW system will be the legal knowledge engineering interface for the construction of advisory systems. It will need to provide a map of the knowledge structure in graphic form. The graphics should have a three dimensional capacity. The construction interface should allow a legal knowledge engineer to fill nodes and create pathways between nodes in flexible, patterns, to suit the domain knowledge and tasks. As far as possible, the shell should permit incremental and module development. Incremental processing allows the expert system to be run at any stage of its development. Module development allows modules to be developed separately and then bolted onto each other as required.

The order and combinations of monads ought to be examinable through a legal analysis process in a TECLAW system. Monads or nodes contain legal data which establishes something about the law and how it is related to other information about the law. A program might proceed not just through the streams, but, dropping out of a stream at the point of a monad, also through streets of information shops, which might have catalogues, and warehouses of primary source law, concerning the monad. A river system might take on Venice characteristics. Furthermore, paths may lead across town from one stream to another or to the shops and warehouses of other monads. Superimposed on the river system, there might be a hyper-text network. The nature of legal information requires this sort of network if all the dimensions of legal reasoning and legal explanation are to be captured.

In practice, it may not be possible to proceed through all potential flows in a river system. Scientific choice is inherently systemic. Order presupposes choice and choice presupposes classification. The process of search for choice in an expert system is essentially a process of classification. Once a decision or action is taken, it may necessarily limit further flow. The determination of choice consistencies and mutually exclusive alternatives, may indicate practical alternatives. In complex systems, one choice leads to another. For the user, some flows give rise to certainties and some give rise to risks. These certainties and risks may constitute an advantage or disadvantage to the user or some other party concerned in the user's case. There may be elements of control or lack of control in respect of the various parties. The problem of the user is to find the route to the solution for the user. A search is required through the order of choices.

A system goal provides a perspective that stabilizes the relativity of information which will assist in the attainment of that goal. Recognising and addressing the different parties who are directly or indirectly involved in the process of goal attainment, further stabilizes the relativity of the information. The determination of recognised choices in the information for each party assists in unravelling the space time amalgam in the knowledge or information. The metaphysical structure in the information which creates the space-time amalgam is to some extent the choice structure or the alternatives-consequences structure. Some alternatives may have time contingencies. Some consequences may be interim jurisprudential consequences. So, for instance, the formation of a valid contract is an interim jurisprudential consequence in a contractual transaction. The performance of a contractual obligation, is usually the delivery of the ultimate benefit which is an ultimate or final consequence of the interim jurisprudential consequence.

A program which is designed as a planning aid, would ask questions which establish the best path along which the user should proceed. This sort of program may be regarded as a critical path program. It might provide output which expresses an evaluation of alternative paths for the user or gives information from which the

user may evaluate alternative paths. Critical path programs require structures which indicate categories such as advantages, disadvantages, risks, controls, or other such variables. A critical path program may select the series of choices which leads to a certain nominated consequence. If more than one path does this, then the program may provide a means for selecting the path which conforms to certain specified requirements, such as least number of risks, most number of controls, most number of benefits, least number of disadvantages. Such an advisory resource may expedite planning. The number of choices which are preserved through a path selection may itself be an advantage.

Learning and planning programs may be designed as games. The law is usually concerned with disputes between people, how they arose and how they are settled. Legal transactions and interactions have game dimensions, and axiomatization of the game can be formalized by reference to the rules of law. It is not possible to predict with certainty what another person will do and what unforeseen circumstances will arise. A player may pose one journey through a riometasystem as the first priority, followed by alternative journeys if preferences can not be achieved. The ways of playing the game may be set out as a series of decision matrices. In the course of a game, a player may jump from one decision matrix to another as the game unfolds. The law regulates human interaction and this sort of matrix-hopping.

The law establishes expectations according to the requirements of law and what the law will do in the various circumstances which might occur. It is possible to plan on the basis of what might happen within the legal framework. The law aids this sort of planning in some instances through an indication of how people might avoid conflicts and minimize the risks of relying on others. These are the rules of the game of law. If a person understands the benefits of the law, he or she can maximize the benefits and minimize the losses of social interaction. For example, if an offer specifies a non-postal mode and time for acceptance, the postal rule which produces a binding contract before actual communication of the acceptance, may be avoided. Practical as well as legal measures may be available to play the best game. A

game program must provide a facility which can deal with the combined choices of all the individuals concerned.

Juristic expert systems may be devised for various purposes. Special procedures might be devised to deal with the analysis and evaluation of law by reference to survival and ethical matters. Through the development of positivist legal expert systems, there may come to light, information which might assist in the development of survival or ethical expert systems and consequent juristic theory and evaluation.

Legal expert systems are limited by jurisprudential systems. The possible relationships between monads can stretch to the domains of chaos, beyond controlled jurisprudential and legal relativity. In this chaotic domain there is an infinite combinatorial explosion. 'Combinatorial explosion' is defined in the Lighthill Report as the way in which the possible states in a multi-step task increase exponentially with the number of choices at each choice point. Jurisprudential system boundaries and structures may limit access to monads and the possible journeys through possible combinations of monads. There are various ways of designing jurisprudential systems to produce viable expert systems. Even when legal knowledge is limited jurisprudentially to reasonable levels of combinatorial explosion, further techniques may be needed to keep the geometasystem manageable. For instance, in some areas of law, it might be possible to construct a pure legal reasoning system only, if an immense number of rules are devised. However, it may not be practicable to formulate such an immense number of rules to achieve this. If the number of rules can be reduced by explanatory heuristics which will achieve the same user purpose, then the legal expert system might be constructed as an explanatory system rather than a pure reasoning system. The law might require understanding rather than mechanical processing of its meaning.

Legal knowledge representation is currently a key issue in the development of artificial legal intelligence. The form of knowledge representation is a system design problem in the task of legal knowledge engineering. The study of design aids is only one of three fields of study in legal knowledge engineering. Legal

choice is a consideration in all three fields, which are as follows:

- . Types of Systems
- . Construction Procedure
- . Design Aids

These fields sometimes overlap. In the development of a particular system, a legal knowledge engineer may find assistance from all three fields. They are the methodology resources and should be accommodated in a TECLAW system. The task of legal knowledge engineering consists of making legal choices which are available within each of these three fields. These choices are made in the course of construction of a system. There is no standard procedure but any procedure which is developed should make provision for appropriate consideration of legal choice. The choices which are made during the construction of a system will produce the automation of choices within the law, relative to legal choices which are made by the user of the legal expert system.

Some types of systems are as follows:

1. Expertise Categorization

Legal expert systems may be classified or specified by reference to the following:

- . The type of legal knowledge in the knowledge base, e.g. precedent forms, common law, legislation.
- . The type of processing, e.g. rule-based, procedural, vector, mathematical calculation.
- . The type of legal task which is emulated, e.g. drafting, documentary procedure, calculation of entitlements, legal reasoning, prognostic advice.

. The major significance of the system.

Legal expert systems may contain one or more of these aspects of legal skills. There are professional tasks which require a knowledge of the rules of law, legal reasoning and the heuristics of legal expertise. Artificial legal intelligence can be understood in these terms.

2. User Benefit Categorization

The nature of a legal expert system may take one of three forms:

. Advisory

An advisory program receives input data concerning people or their environment and provides output data which may be legal information, ethical information, information about what the user might expect, or advice on what the user should do.

. Learning or Exploratory

A learning or exploratory program receives from the user input about the legal system or about the area of law that the user wishes to learn and provides output data about the user's input. The user may be shown the law or an interpretation of it, or tested on knowledge about the legal system.

. Combined advisory/learning or exploratory

In combined programs, the user may be advised on the jurisprudential consequences of her or his situation, and also has the opportunity to discover the reasons for these consequences, and what to do next.

Early in the construction of a system, decisions will have to be taken as to the type of system which is to be built. The range of system types is another form of legal choice. A TECLAW system should accommodate an adequate range of systems.

Conclusion

A considerable amount of research is underway to develop both a suitable computer environment and an appropriate legal knowledge engineering methodology, in order to meet the requirements of the legal system. There are three schools of thinking. The first of these schools is the natural legal language school which is attempting to develop a comprehensive legal language semantic processor. The second is the deontic logic school which looks to the development of a comprehensive deontic logic as the basis for designing a legal semantics processor. Finally, there are the metaphysical modellers who attempt to chart the metasystems of legal knowledge in order to design a standard processor. These three schools of thought are approaching the same problem from three different angles. It might be expected that eventually they will be brought together in a powerful synthesis. The deontic logic will probably be settled and explained by reference to the metaphysical models, and the legal language requirements will qualify the deontic logic. However, there might be other scenarios of reconciliation of the approaches. In any event, it has been recognised in recent years that different forms of knowledge representation are inter-changeable and the diversity simply provides alternative views of the same information. It may be that different legal choices will be seen from each angle when legal knowledge representation has been mastered.

For the last two decades, many innovative systems have been produced through the co-operative effort of lawyers and computer specialists. Due to the interdependence of shells and methodology, and the great many dimensions of the legal system, it might be expected that advances will be made gradually and that a competent TECLAW system will not be perfected for perhaps another fifty years. In the meantime, legal knowledge engineering has entered an era of jurisprudential discovery, which may foster the development of new dimensions of artificial intelligence.

Footnotes

- (1) See M. Lupoi, The Decisional Computer as a Source of Law, in C. Ciampi, (ed.), Artificial Intelligence and Legal Information Systems, North-Holland Publishing Company, Amsterdam, Holland, 1982, Volume 1 of the papers of the first

- Florence Conference, Logic, Informatics, Law, held in 1981, pages 733-776.
- (2) For a history of hardware development see N. Metropolis, J. Howlett and G-C. Rota, A History of Computing in the Twentieth Century, Academic Press, New York, U.S.A., 1980.
 - (3) The Society of Mind, Simon and Schuster, New York, U.S.A., 1986.
 - (4) In 1937, Shannon wrote a masters thesis in engineering at M.I.T. which showed that the operation of electrical relays and switching circuits could be analysed as logical elements such as True, False, Not, And and Or. See also his information theory, A Mathematical Theory of Communication, Bell System Technical Journal, 27 July/October 1949, pages 379-423; 623-656.
 - (5) Computer Applications in the Law, West Publishing Co., St. Paul, Minnesota, 1987 page 5.
 - (6) Ibid. page 6.
 - (7) Ibid. page 7.
 - (8) Ibid. page 6.
 - (9) Ibid. pages 9-10.
 - (10) Ibid. page 15.
 - (11) The Knowledge Industry in R. Forsyth, (ed.) Expert Systems, Chapman and Hall, London, England, 1984, page 212.
 - (12) In R. Forsyth, (ed.) ibid. pages 68-9.
 - (13) REVEAL: An Expert Systems Support Environment, in R. Forsyth, (ed.) ibid. page 134.
 - (14) Op. cit. page 66.
 - (15) Second edition, Addison-Wesley, Reading, Massachusetts, 1984, page 1.
 - (16) Ibid.
 - (17) The first programmable computer was built in Germany during the Second World War by Konrad Zuse. However, his work was not recognised. The earliest calculating machine was designed by Blaise Pascal (1623-1662), the French scientist, as a system of cog-wheels.
 - (18) John Wiley and Sons, New York, U.S.A., revised edition, MIT Press, Cambridge, Massachusetts, 1961. See also W. Ross Ashby, An Introduction to Cybernetics, University Paperbacks, Methuen, London, England, 1964 (first published in 1956).

- (19) See F. Rosenblatt, *The Perceptron: a Perceiving and Recognizing Automaton*, Cornell Aeronautical Lab, New York, U.S.A., 1957. See also N.M. Amosov, *Modeling of Thinking and the Mind*, translated by Leo Finegold, translation edited by Lawrence J. Fogel, Spartan Books, New York, U.S.A., 1967, originally published in the U.S.S.R. in 1965.
- (20) See M.M. Waldrop, *Man-Made Minds*, Walker and Company, U.S.A., 1987, pages 20-33.
- (21) The term 'heuristics' is derived from the Greek term *heuriskein*, meaning to invent or discover. During the 1940's, George Polya, a Stanford mathematician, popularized the term through his studies of human problem-solving; he was a lecturer of Newell.
- (22) See N. Metropolis, J. Howlett, G-C. Rota, *op.cit.* page 208.
- (23) *Op. cit.* page 5.
- (24) See G. Ernst, and A. Newell, *AGPS: a Case Study in Generality and Problem Solving*, Academic Press, New York, U.S.A., 1969.
- (25) See R. Lindsay, B.G. Buchanan, E.A. Feigenbaum, and J. Lederberg, *Applications of Artificial Intelligence for Chemical Inference: The Dendral Project*, McGraw-Hill Book Company, New York, U.S.A., 1980.
- (26) American Elsevier/North-Holland, New York, U.S.A.
- (27) *Op. cit.* page 13.
- (28) See M.M. Waldrop, *op. cit.*, Chapter 8. For details of Alvey Projects and ESPRIT Projects see S.E. Savory (ed.), *Artificial Intelligence and Expert Systems*, Ellis Horwood Ltd and John Wiley and Sons, Chichester, England, 1988, Appendix C.
- (29) *Expert Systems*, *op. cit.*, 1984, Foreword.
- (30) 33 *Minn. L. Rev.* 455 (1949); see also R. Pound, *Mechanized Jurisprudence*, 8 *Colum L. Rev.* 605 (1908), and L. Mehl, *Automation in the Legal World - From the Machine Processing of Legal Information to the "Law Machine"*, in *Mechanisation of Thought Processes*, the Proceedings of a Symposium held at the National Physical Laboratory, NPL, 1958. Mehl, a French lawyer, founded the French legal information retrieval service, CEDIJ.
- (31) *Legal Information Services: Some Trends and Characteristics*, in C. Campbell, (ed.) *Data Processing and the Law*, Sweet and Maxwell, London, England, 1984, page 29.
- (32) J. Bing, (ed.), North-Holland, Amsterdam, Holland, 1984.
- (33) See C.F.H. Tapper, *Lawyers and Machines* (1963), 26 *Modern Law Review*, 121, and C.F.H. Tapper, *Computers and the Law*, Weidenfeld and Nicolson, London, England, 1973.

- (34) Jurimetrics: The Methodology of Legal Inquiry, in Hans W. Baade, (ed.) Jurimetrics, Basic Books, New York and London, 1963; originally published as Volume 28, Number 1 (Winter 1963), of Law and Contemporary Problems, Duke University School of Law.
- (35) Reprinted in 1920 as Learning and Science in Collected Legal Papers, page 138.
- (36) Op. cit. page 1.
- (37) L.E. Allen, and M.E. Caldwell, (eds) The Bobbs-Merrill Company, Inc., Indianapolis U.S.A.
- (38) See the Proceedings of the First Round Table on Law and Semiotics, held 11-13th April 1987 at the Center for Semiotic Research in Law, Government, and Economics, Pennsylvania State University, published as R. Kevelson, (ed.) Law and Semiotics Volume 1, Plenum Press, New York and London, 1987. Also see Kevelson, R., The Law as a System of Signs, Plenum Press, New York and London, 1988.
- (39) Op. cit. page 71.
- (40) Ibid page 74.
- (41) See V. Knapp, O vozmoznosti ispolsovanija kibernetitjeskich metodov v prave (On the Possibilities of Using Cybernetic Methods in the law), Progress, Moscow, U.S.S.R., 1965.
- (42) Op. cit. page 226.
- (43) Ibid. page 228-9.
- (44) Autotelic, New Haven, Connecticut, 1962.
- (45) Analysis of the Logical Structure of Legal Rules by a Modernized and Formalized Version of Hohfeld Fundamental Legal Conceptions, in A.A. Martino, and F.S. Natali, (eds) Automated Analysis of Legal Texts, North-Holland, Amsterdam, Holland, 1986, page 385; see also W.N. Hohfeld, Fundamental Legal Conceptions as Applied in Judicial Reasoning, in Yale L.J., 1913, 23, 16-59.
- (46) Op. cit. See in particular pages 143-203. Also see: C. Campbell, (ed.),
- (47) Oxford University Press, Oxford, England, 1987, pages 4-6. See also J. Bing (ed.), Handbook of Legal Information Retrieval, op. cit., for a description of legal information retrieval systems developed in various countries, and the extent of their use.
- (48) (1970), 23, Stanford Law Review, 40.
- (49) See L.T. McCarty, Interim Report on the TAXMAN Project: An Experiment in Artificial Intelligence and Legal Reasoning, Stanford Law School Workshop on Computer Applications to Legal Research and Analysis, 28-9 April 1972. See also L.T.

- McCarty, Reflections on TAXMAN: An Experiment in Artificial Intelligence and Legal Reasoning, (1977), 90, Harvard Law Review, 837.
- (50) See L.T. McCarty, Intelligent Legal Information Systems: Problems and Prospects, Rutgers Computer & Technology Law Journal, Volume 9, No. 2, page 265-294, at pages 267-268; also published in C. Campbell, (ed.), op. cit. (based on a paper presented at a Colloquium on Data Processing and the Law at Leicester, U.K. in 1982)
- (51) See page 180 of the Vancouver proceedings, published by The Association for Computing Machinery, New York, 1989.
- (52) Permissions and Obligations, in A.A. Martino, and F.S. Natali, (eds.), op.cit. page 311.
- (53) A Relational Model of Data for Large Stored Data Banks, CACM, 13, pages 377-387.
- (54) See R. Stamper, LEGOL: Modelling Legal Rules by Computer in B. Niblett, (ed) Computer Science and Law, Cambridge University Press, Cambridge, 1980, page 45; Developing the Legol Semantic Grammar, in A. Ciampi, (ed.), pages 357-379. See also: B. Niblett, Computer Science and Law: An Introductory Discussion, in B. Niblett, (ed.) op. cit. page 7.
- (55) See Florence conference paper by R. Stamper, published under the title, A Non-classical Logic for Based on the Structures of Behaviour, (There appears to be some typographical error in this title) in A.A. Martino, and F.S. Natali, (eds) op. cit. pages 115-140.
- (56) See A. Horn, On Semantics Which Are True of Direct Unions of Algebras, in J. of Symbolic Logic, 1951, 16, pp. 14-21.
- (57) Automating Knowledge Acquisition, in R. Forsyth, (ed.) op. cit. page 192. RADA
- (58) Addison-Wesley Publishing Company Inc., Reading, Massachusetts, 1983, page 399.
- (59) Ibid. page 400.
- (60) Artificial Intelligence, Addison-Wesley Publishing Company, Reading, Massachusetts, second edition, 1984, page 152.
- (61) Kegan Paul, Trench, Trubner & Co., Ltd., New York, U.S.A., page 10.
- (62) Expert Systems in Law, op. cit. page 209.
- (63) See Chris Naylor, Build Your Own Expert System, Sigma Technical Press and John Wiley, Chichester, England, 1983.
- (64) How to Build an Inferencing Engine, in R. Forsyth, (ed.) op. cit. page 80.

- (65) See J. Bing, Legal Norms, Discretionary Rules and Computer Programs, in B. Niblett, Computer Science and Law, Cambridge University Press, Cambridge, England, 1980.
- (66) See A. Tyree, Expert Systems in Law, Prentice Hall, New York, U.S.A., 1989, page 140.
- (67) An Artificial Intelligence Approach to Legal Reasoning, MIT Press, Cambridge, Massachusetts, 1987, page 74-5.
- (68) Op. cit. page 140.
- (69) Volume 3, Butterworths, London, page 119. See also A. Tyree, op.cit., Chapter 4.
- (70) Word Concepts: A Theory and Simulation of Some Basic Semantic Capabilities, Behavioural Science 12 (1967). pages 410-430.
- (71) In J. Haugeland, (ed.), Mind Design, MIT press, Cambridge, Massachusetts, 1981, pages 95-128.
- (72) Scripts, Plans, Goals and Understanding, Lawrence Erlbaum, Hillsdale, New Jersey, 1977.
- (73) Op. cit. pages 51-52.
- (74) Ibid.
- (75) For a review of current tax packages see Today's Computers, June 1985, pages 25-33.
- (76) Adaptive Learning Systems, in R. Forsyth, (ed.) op.cit. page 168.
- (77) R. Susskind, op. cit. page 27.
- (78) For an exposition of this system see D.I. Gold, Specification and Implementation of an Expert System in Law, Oxford University D.Phil. thesis 1987.
- (79) The system is sold with an explanatory book, Latent Damage Law The Expert System, Butterworths, London.
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- (81) Widdison has not published this view but explained the finding to the author in discussions about the author's river system in Durham in February 1989.
- (82) Op. cit.; see also Overview of an Artificial Intelligence Approach to Legal Reasoning, in C. Walter, (ed.), Computing Power and Legal Reasoning, West Publishing Company, St. Paul, U.S.A., 1985, pages 247-317. For a review and criticism of Gardner's work see E.L. Rissland, Artificial Intelligence and Legal Reasoning, AI Magazine, Fall 1988, pages.45-54.
- (83) An Artificial Intelligence Approach to Legal Reasoning, op. cit. pages 4-5.

- (84) Ibid. page 190.
- (85) The series has an international editorial board and is now published by Butterworths.
- (86) J. Bing, (ed) op. cit. For the Australian equivalent see G.W. Greenleaf, A.S. Mowbray, and D.P. Lewis, The Australasian Computerized Legal Information Handbook, Butterworths, Sydney, Australia, 1988.
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- (88) See for example L.T. McCarty, Permissions and Obligations, in A.A. Martino, and F.S. Natali, (eds.), op.cit. page 307 ff.
- (89) For a computer analogy of this see M.T. Harandi, and M.J. Schoppers, Meta-logic Programming in Metalog, in A.A. Martino, A.A. and F.S. Natali, (eds.), op.cit. p.247 ff. Metalog is a language which combines both declarative and imperative programming. See also H-N Castaneda, Aspectual Actions and the Deepest "Paradox" of Deontic Logic, ibid. pages 31 ff. and R. Stamper, A Non-Classical Logic For Based on the Structures of Behaviour, op. cit.
- (90) See Martino's Introduction in A.A. Martino, and F.S. Natali, (eds.), op.cit. page xxi.
- (91) In conversation with the author at the 1989 Vancouver Conference. JEDA is described in the conference paper: Vishwas P. Pethe, Charles P. Rippey, and L.V. Kale, A Specialised Expert System for Judicial Decision Support, in the Proceedings of the Second International Conference on Artificial Intelligence and Law, op. cit. pages 190-194.

- (92) See E.L. Rissland, and D.B. Skalak, Interpreting Statutory Predicates, in the Proceedings of the Second International Conference on Artificial Intelligence and Law, op. cit. pages 46-53.
- (93) See A. Oskamp et ors., PROLEXS, Divide and Rule, in the Proceedings of the Second International Conference on Artificial Intelligence and Law, op. cit. pages 54-62.
- (94) For a comparison of shells see R. Freedman, Evaluating Shells, AI Expert, September 1987, Vol.2, No.9, pages 69-74.
- (95) See F. Waismann, Verifiability, Proceedings of the Aristotelian Society, supp. 19, 119-150; H.L.A. Hart, Concept of Law, Clarendon Press, Oxford, 1961, pages 121-132; R. Susskind, op. cit. pages 186-193; A.v.d.L. Gardner, op.cit. page 2 and page 195nl.
- (96) See Lewis v Averay [1971] 3 All E.R. 907.
- (97) Letter to the author dated 24th April 1988.
- (98) For a discussion of the automation of perspectives see P.H. Winston, op.cit. pages 261-3.
- (99) An example of this is the argument put by G. Brennan, Q.C., as he then was (now Justice Brennan of the High Court of Australia), counsel for the plaintiff in Budget Rent-a-Car Systems Pty Ltd v B.M. Auto Sales Pty Ltd and Measey Investments Pty Ltd trading as Budget Rent-a-Car (1974) Northern Territory Judgments 1951-1976, page 919 ff., a passing off action. The author acted as the plaintiff's instructing solicitor in this case.
- (100) For an expose of blackboard systems, see Robert Englemore and Tony Morgan, (eds.) Blackboard Systems, Addison-Wesley Publishing Company, Wokingham, England, 1988.
- (101) A.A. Martino, and F.S. Natali, (eds.) op. cit. page xvii.
- (102) Ibid. page xxi.
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- (105) Expert Systems, The National Computing Centre Limited, Manchester, England, 1984, page 17.
- (106) Ibid. page 19.
- (107) Knowledge Engineering in PROLOG, in R. Forsyth, (ed.) op. cit. page 95.
- (108) Op. cit. page 191.
- (109) Op. cit. page 96.
- (110) Op. cit. page 190-1.

- (111)Op. cit.
- (112)Op.cit. page 31.
- (113)Op. cit. page 12. For a similar view see P.H. Winston,
op.cit. page 22.
- (114)See for example, P.H. Winston, op.cit. Chs.2 and 4.
- (115)Op.cit. page 288.
- (116)Op. cit. page 17.
- (117)Op. cit. page 191.
- (118)Ibid. page 183
- (119)Op.cit. page 403.
- (120)A New Approach to the Logical Theory of Actions and
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- (122)Demand-Driven Model for a Half-Intelligent System, in C.
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- (123)Future Generation Computer Systems in the Service of the Law,
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1986, page 643; see also J.M. Unger, The Fifth Generation
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- (124)Object-Oriented Predicate Logic and its Role in Representing
Legal Knowledge, in C. Walter, (ed.), op.cit., pages 163-203.
- (125)Op.cit. page 134.

CHAPTER EIGHT

FUTURE LEGAL SCIENCE :

COMPUTERIZED CODIFICATION

OF LEGAL SERVICES

In the Computer Age, the English legal system is likely to undergo marked changes. An indication of the sort of changes which can be expected may be found by examining contemporary problems in the legal system, the evolution of legal systems, and the resources which are likely to be employed in the future. This thesis has addressed the contemporary problem of failures in the legal system in the provision of legal information and in the provision of opportunities for optimum satisfaction of individual survival needs and wants. The historical chapters have traced the evolution of law and science and its interaction, as well as mapping out a life cycle of a legal system, namely the Roman legal system, as a precedent for understanding the current position of the life cycle of the English legal system. In addition, the historical chapters have examined the resources of human intelligence which might be used in the future. Some of the resources which have been developed since the second World War, and which are likely to be used in the future, also have been examined in Chapters Six and Seven. In addition, the thesis has offered new resources which might clarify the nature and direction of change, in particular the general jurisprudential system, SURMET, and the legal knowledge engineering design aid, the world of rivers paradigm.

The contemporary problems of the legal system are twofold. Firstly, there is a failure to found the law on human survival principles in a scientific way. Secondly, the law is not adequately accessible to those whom it is intended to benefit. If these problems are considered in the context of the current evolutionary stage of our legal system, then it is appropriate to consider whether a codification of the law, according to available contemporary scientific means, could provide a solution to these problems.

Computerized codification could make the law accessible to people if it took the form of computerized legal services. The simple retrieval of primary source law is not the sort of access to the law that is appropriate for non-lawyers. The access required is access to the behavioural implications of the law in the circumstances of the user. The user wants to know what opportunities for the satisfaction of personal needs and wants the

law allows in the circumstances: what the user may or must do or not do, and what are the user's choices. These opportunities should be determined according to an intelligent management of human survival, given the survival principles which can be empirically determined. Codification should incorporate survival law if it is to provide a solution to the contemporary problems.

Contemporary resources may be used to establish this sort of codification. However, extensive research is required to achieve and maintain the codification in a fully operational form. The very nature of computer technology requires the dedication of a group of specialists in law and in other sciences. The indications are that legal science must become more interactive with, and closely related to, the other sciences.

Systems science provides a major paradigm, namely that of system itself, through which the various sciences can communicate. As Bertalanffy observes:

The system concept provides a theoretical framework which is psychophysically neutral.(1)

Russell L. Ackoff, in his book, *Redesigning the Future: A Systems Approach to Societal Problems*, captures the impact of the contemporary Systems Age as follows:

In the early 1950's science went through an 'aha' experience and came to realize what it had been up to in the preceding decade: it was becoming preoccupied with systems. ... (2)

Scientific disciplines are no longer thought of as dealing with different aspects of Nature, nor is Nature believed to be organized in the same way as science is. The disciplines are increasingly thought of as points of view most of which are applicable to the study of most phenomena and problems. (3)

Because the Systems Age is teleologically oriented it is preoccupied with systems that are purposeful; that is, with systems that can display choice of both means and ends. (4)

The early signs of a more advanced legal science, apart from the field of computer jurisprudence, appeared in Europe in 1983 with the Conference on Legal Theory and Philosophy of Science, held at

Lund University, Sweden.(5) The legal science tradition at Lund dates back to the late seventeenth century when the University was founded and Samuel Pufendorf taught there. At the 1983 Conference, the search for paradigms of legal science by reference to scientific paradigms was paramount. Many of the papers specifically addressed the Kuhnian theory of scientific paradigms, with a view to identifying and evaluating current paradigms of legal science and providing new paradigms for the development of the field more closely with the other sciences.(6)

A consideration of existing resources of science including legal science, indicates, to some extent, the sort of developments that might be expected in jurisprudence and in computer science, in order to provide codified on-line legal services that will suit human needs and wants. Some developments will be concerned with construing the existing rules of law in terms of behavioural choices. Other developments will be concerned with structuring and drafting this interpretation of the law as a computational system, that is, as a geometasystem. Finally, adaptations of computer processing will be required to process legal services. These three courses of development will be interactive and must be integrated in the final result.

Paradigms of human intelligence which have proved stable over a long period of time may assist in guiding the development. Such paradigms might include atomism, logic, relativity, choice, geometry, and communication. Studies have already been established in the fields of the logic of choice, logical atomism,(7) and relative geometry.(8) It might be expected that the cross-fertilization of these ideas will produce specialized studies such as relative logic, communication logic, and the geometry of choice. Logicians have developed calculi for propositions, functions and relations. These may be useful in the development of artificial legal intelligence, especially in the construction of a legal knowledge engineering tool to build programs with multiple integrated processes.(9)

Gidon Gottlieb, in his book, *The Logic of Choice*, published in 1968 examines the nature of choice in judicial decision

-making.(10) His analysis of reasoning with rules might be applied, not just to judicial reasoning, but also to the reasoning in legal services, especially the reasoning recommended to a client who is looking to legal logic to find a pathway, or the best pathway, to a legal goal.

The logic of legal services, which includes the logic of the law, must be clarified and formalized. J. Walter Jones raised the view that the law is based on the logic of facts (11); at the same time, as he also maintained that the law is full of fictions, (12), a domain 'as if'. Perhaps there is a logic of fact and a logic of fictions imbedded in the law.

The logic of settled law, which is applied to a case by a process of deduction, must be distinguished from the lateral thinking and other techniques by which judges expand or contract the settled law. For codification of legal services, settled law must be streamlined to user perspectives and user communication forms. Advice and reasons must be at the theoretical level and also at a social level. However, the power of judicial decision-making is a factor to be considered in applying settled law. The exercise of judicial power and its consequence for a legal game may be regarded as one of the rules of the legal game. The rule is that the rules may be changed by judicial or legislative intervention.

As was pointed out by Charles Fried in his article, *The Laws of Change: The Cunning of Reason in Moral and Legal History*, published in 1980,(13) judicial reasoning must accommodate the settlement of the conflict before the court, the justification for imposing that settlement and the means for predicting future social conduct. Legal services are concerned with all these facets. The paradigm of rules of law accommodates all of these requirements. However, for computational purposes, the juridical knot must be unravelled. Its complexity requires a relative logic, a fabric which can capture all its strands.

There is no consensus about what logic is. It is of various types and plays various relative roles in the legal system. Normative logic may be regarded as a quasi-truth logic. It has elements of truth and elements of authority. Its propositions may be true in

fact, and valid as choices. The sequence of propositions may also be true in fact, valid as choices, and relatively true as between themselves, that is, consistent. In order to formalize legal logic, the nature of logic itself must be more extensively examined. The meta-rules or heuristics of logic must be discovered. The meta-rule which states that the paradigm of a syllogism is true, rests on the validity of the notion of a priori, or upon common experience. The truth of the substantive content of a syllogism, also rests on the a priori or experience.

The development of deontic logic by jurists such as Alchourron and Bulygin has provided new structures for legal logic. For instance, a formal view of a rule can be set out as protasis (operative fact) and apodosis (resulting fact). Where there is a choice of action, there is an action logic and a situation logic, as well as a logic of choice. The form of legal logic may be found in the semantics of legal choice. Herbert A. Simon adopts the view that heuristics, which entail practical choice and practical logic, constitute a logic of action.

The task of a comprehensive theory of action is to describe or prescribe the occasions for action, the alternative courses of action (or the means of discovering them), and the choice among action alternatives. The task of a comprehensive logic of action is to describe or prescribe the rules that govern reasoning about the occasions for action, the discovery of action alternatives, and the choice of action.(14)

Doing nothing, if it can be identified at all, is simply a particular way of doing something, not distinguished in the theory from all other forms of action.(15)

In order to make the legal system more effective, law should be studied as a description as well as a prescription of human behaviour. The behaviour which is prescribed to achieve legal consequences, should be clearly described and systematized, so that its complexity can be understood by the lay user. Relevant extraneous matters should also be accessible at appropriate places in the system. A unified study of law and behaviour was proposed by Alfred de Grazia in 1960.(16)

A codification of legal services may be seen as a system of decisions rather than as a system of rules. Decisions might be taken according to goals and advice. The struggle for survival with which the user is concerned, then becomes a matter of the struggle for informed decision-making within the framework of the collective artificial intelligence. As conceived by Rudolf Von Ihering, law may be treated as a means to the ends of human survival: its purpose is to serve human survival.(17)

Logic is relative to context. There remains in systems science the problem of relativity. This was pointed out by I.V. Blauberg, V.N. Sadovsky and E.G. Yudin.(18) Each fragment of systems knowledge must be fitted to each other fragment and there may be many different ways of fitting them together. Any suitable fit may be dynamic, with its own cycle of changes. Equity, in the Aristotelian sense, may very well represent the dynamics of the metaphysical engine of law. The SURMET proposal suggests a high level relativity in survival law. The ongoing recombination of factors in the world may constitute an element of change, in which human choice participates but exercises only limited control. If the nature of equity is exception to the rule which is unpredictable, it seems that equity must be dynamic, and that it plays a significant role in establishing and maintaining legal choice.(19)

The boundary logic which is proposed in Chapter Seven, may solve some of the problems of context. It is a dynamic boundary. Within the boundary, the structure of a jurisprudential system provides a framework of reference points to stabilize relativity and make things more controllable. If the jurisprudential system incorporates a mirror version of the environment, this may act as a further stabilization of the relativity and chaos of the external environment. The heuristics of jurisprudential systems design may act as short cuts in legal logic.

The boundary logic proposed in the world of rivers paradigm in Chapter Seven, has been previously acknowledged in science. It is referred to by Losee as follows:

Antecedent conditions include both the boundary

conditions within which the laws are believed to be applicable, and those initial conditions which are realized prior to, or at the same time as, the phenomenon to be explained.(20)

The dynamic and static states of the world of rivers also captures the duality of logic which Simon has recognized. He says that there are two different spaces that must be accommodated in the design of a heuristic decision making program:

Design problems - generating or discovering alternatives - are complex largely because they involve two spaces, an action space and a state space, that generally have completely different structures.(21)

The paradigm of two states is fundamental in physics: in the electromagnetic field there are two forms of energy, represented as magnetic polarization and electric polarization. The magnetic polarization might correspond to the riometasystem in the world of rivers paradigm, and the electric polarization might correspond to particular journeys from time to time as they zig-zag through the riometasystem. It is also interesting to note that SURMET, within which many worlds of rivers may be nested, closely resembles one of Amosov's models of the human brain.(22)

It was pointed out by H.F. Jalowicz, that human law presupposes human choice: it directs people in the constraint of natural choice.(23) The many choice perspectives on law will maximize the choice satisfaction that can be got out of the system. The law should be evaluated in its full potential for choice before any criticism is made or changes considered. Studies of systems of freedom are likely to contribute to the development of artificial legal intelligence. Ervin Laszlo has provided a basis for these studies in his broad coverage of the field of systems theory.(24) He treats freedom as a matter of choice.

SURMET provides a framework for determining legal choice that is rationalised with the natural laws of survival. No hierarchy in natural law has yet been developed. In a sense, these laws, amongst themselves, struggle for dominance. Natural laws of survival law may justify legal choice, not so much because they

are natural, but because they are inescapable. For this reason, rational law must take account of them.

If survival laws are relative and require different ordering from time to time when conflicts arise - the paradigm of the Markov chain may be useful. A Markov chain occurs when the probability of one event is determined by the probability of the preceding event. As the probability of one event is adjusted so the probability of other events are adjusted. Alan Tyree suggests that the processing required for an evolution of the law should rest on the variable weighting of relevant facts.(25) Holmes saw that, in the judicial process, there was a paradigm of the struggle among ideas.(26) In judicial selection of law, the rules evolve. In the legal choices of lay people, there is also an evolutionary process, but it is not confined to the law.

The codification of legal services may provide greater control over the integration of judicial and lay evolutionary processes. If the codification is used customarily, it may become a new form of customary law. Further, if the codification is based on sociologically managed survival law, as suggested by SURMET, there may be an opportunity for refined co-ordination of relative ethics suited to individual requirements for satisfaction of needs and wants.

The law may become the pivot for information flows in society. This would remove social emphasis on power, and place more emphasis on intelligence. The judiciary may play a specialized role in the group of scientists maintaining the codification. When conflict arises, the resources of the whole group might be brought to bear on the problem. The solution might be looked for in the full scope of scientific resources. A feedback module in the codification could facilitate the monitoring of the codification's effectiveness. Criminal system may remain as an archaic vestige of law until codification solutions can be found. The legal profession may supplement the system with their own versions of choice in it and advice on how to do best out of it.

The codification is likely to be integrated with a broader based social management system which rationalises production and

distribution to provide for the needs and wants of people. The system might entail less stress for users because the reason for their behaviour might be sought and accommodated, and because it will provide speedy intelligent support tailored to their personal requirements. The future holds changes for jurisprudential thinking, legal practice, and the legal system itself. Jurists are likely to be drawn into a more holistic management of science and society, to serve human survival.

The logic required for the computerization of legal services, must be computational, and capable of being modelled so that the design of a program can be interfaced with the world of client reality. A formal legal logic must be able to accommodate the law and what is implicit in law from moral, economic or other perspectives.

The development of jurisprudential systems is aided by the intelligence paradigms of the collective consciousness. Stable juristic paradigms from the past might add to the development of a system of collective intelligence. William Galbraith Miller examined a broad range of juristic paradigms in his book, *The Data of Jurisprudence*, published in 1903.(27) He covered many stable paradigms such as right, title, power, cause, status, authority, duty, as well as forty-four perspectives of how law might be regarded, sixteen views of custom, and thirteen ways of looking at the aims of the law. In further development of artificial legal intelligence this work might prove to be a useful resource.

Thomas Hobbes, in his early work, *The Elements of Law Natural and Politic*,(28) published in 1640, attempted to establish a legal framework based on the psychology of the individual, the certainty of science, and the established legal system. Shortly after, he became embroiled in local politics and was forced to flee to Europe. His later works were perverted to, and exploited by, political interests. He developed *Leviathan*, the artificial collective intelligence of society. A codification of legal services is a codification of *Leviathan*. Whether or not political power will again exploit progress along this path may depend upon the decisions of the group of specialists who will be required to work together to maintain this line of development. The

codification might also realise the stoic ideal of autonomy of the individual within a rational society.

In order to achieve a codification of legal services, specialised studies of law in relation to the elements of semantic computation is required. These might include the studies which take up the leads of Nelson Goodman who has studied the structure of appearance (29), Doede Nauta, who has studied the meaning of information (30), and Colin Cherry who has studied communication, including the logic of communication.(31) Cary G. deBessonnet observed in his article, A Proposal for Developing the Structural Science of Codification, published in 1980:

Conceptual clarification results naturally from the processing and structuring of semantic content.(32)

The same view was stated by Reed Dickerson.

No one can successfully program a problem for machine solution without developing a deep and detailed understanding of the substance of what he is dealing with.(33)

The opportunities for enhancement of intelligent human life through a codification of legal services is captured in the words of Herbert A. Simon states:

Human beings are information processing systems operating largely in serial fashion, and possessing very modest computational powers in comparison with the complexity of the problems with which their environment confronts them. Their survival depends on attending selectively to that environment, and on finding satisfactory behavioural alternatives for handling those problems to which they attend.

Hence a theory of decision making is concerned with processes for selecting aspects of the environment for attention, processes for generating alternatives and processes for choosing among alternatives.(34)

Human intelligence may have been studied in order to build artificial intelligence aids. In the domain of artificial legal intelligence, the study has come full circle to a high tech science of law. Artificial intelligence may now be studied to discover more about intelligence. This view is captured in the

definition of artificial intelligence given by Eugene Charniak and Drew McDermott.

Artificial intelligence is the study of mental faculties through the use of computational methods.(35)

This may be part of the process of intelligence becoming aware of itself, or of the cosmological phenomenon which Hofstadter called strange loops - mirrors that reflect mirrors. Metaknowledge is knowledge of the metarules - ad infinitum. It works as the dynamic search of the static knowledge and is part of the phenomenon of metaphysical relativity.

The complexity of legal knowledge which is now opening up through computer jurisprudence is demonstrated in the Venn diagram of C.F. Walter depicting intersections of open-textured legal concepts. The diagram captures in a static form the metaphysical relativity implicit in overlapping open-textured concepts, especially where each concept has various levels of definition, or modularity, and the levels of each concept add to the complexity of the overlapping.(36)

Legal knowledge engineers must accommodate these difficult dimensions of legal knowledge. In the construction of automated legal services, they are concerned with the implications of the law. D.I. Gold and R.E. Susskind state clearly, the inescapable jurisprudential implications in artificial legal intelligence.

It is beyond argument, however, that all expert systems must conform to some jurisprudential theory because all expert systems in law necessarily make assumptions about the nature of law and legal reasoning.(37)

Computer scientists are now considering the automation of the complexities of human intelligence. In their paper, Expert Systems and Rule Based Decision Support Systems, J. Efstathiou, V. Rajkovic, and M. Bohanec envisaged an advanced processing tool which would meet the broad range of requirements for decision-making.

We believe that a flexible decision support

environment is needed, with a toolbox of techniques that allow the elicitation of knowledge, consistency checking, evaluation of options, explanation of reasoning, induction of general rules and generation of new options.(38)

A holistic scientific tool may very well accommodate the requirements for a TECLAW system, and promote the cohesion of social management which the new technology promises.

Footnotes

- (1) Op. cit. page 232:
- (2) John Wiley and Sons, New York, U.S.A., 1974, page 12.
- (3) Ibid. page 15.
- (4) Ibid. page 18.
- (5) For the Proceedings of the Conference see: A. Peczenik,, L. Lindahl and B. van Roermund, Theory of Legal Science, D. Reidel Publishing Company, Dordrecht, Holland, 1984.
- (6) For example see the following papers: Aulis Aarnio, Paradigms in Legal Dogmatics, *ibid.* pages 25-38; Stig Jorgensen, Pluralis Juris, *ibid.* pages 121-132, especially at pages 124-125; Jan M. Broekman, Changes of Paradigm in the Law, *ibid.* pages 133-144.
- (7) Logical atomism was developed by L. Wittgenstein in Tractatus Logico-Philosophicus, Routledge and Kegan Paul, London, England, 1922, and by B. Russell in Logic and Knowledge, Allen and Unwin, London, England, 1956.
- (8) For instance, the co-ordinate geometry developed by Descartes.
- (9) See, for instance, the work of F.H. George, Models of Thinking, George Allen and Unwin Ltd., London, England, 1970.
- (10) George Allen and Unwin Ltd., London, England, 1968.
- (11) Historical Introduction to the Theory of Law, Clarendon Press, Oxford, England, page 100
- (12) Ibid. page 173.
- (11) The Journal of Legal Studies, Volume IX (2), March 1980, 335-353 at 337.
- (12) The Logic of Heuristic Decision Making, in Nicholas Rescher, The Logic of Decision and Action, University of Pittsburgh Press, 1966. page 1.
- (13) Ibid. page 3.

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- (14) Law and Behaviour: A Unified Approach to Their Study, reproduced in Michael Barkun, (ed.) Law and the Social System, Lieber-Atherton, New York, U.S.A., 1973.
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- (15) Law as a Means to an End, translation of the fourth edition, 1903, by I. Husik, originally published in 1877, The Boston Book Co., Boston, U.S.A., 1913. See also R. Von Ihering, The Struggle for Law, translated by John J. Lalor, fifth edition, Callaghan and Co., Chicago, U.S.A., 1879.
- 8
- (16) Systems Theory: Philosophical and Methodological Problems, translated by Sergei Syrovatkin and Olga Germogenova, Progress Publishers, Moscow, U.S.S.R. 1977, page 282.
- 9
- (17) See Vincent Luizzi, Logic and the Procedure of Equity, in A.A. Martino and F.S. Natali, op. cit., pages 99-103.
- 20
- (18) Op. cit. page 159.
- 21
- (19) Op. cit. page 20.
- 22
- (20) Op. cit. page 121.
- 23
- (21) Lectures on Jurisprudence, The Athlone Press, London, England, 1963, page 33.
- 24
- (22) Introduction to Systems Philosophy. Toward a New Paradigm of Contemporary Thought, Gordon and Breach, New York, U.S.A., 1972.
- 25
- (23) Can a "Deterministic" Computer Judge Overrule Himself?, Rutgers Journal of Computers, Technology and the Law, Volume 7, No 2 1980, 381-4. See also Donald H. Berman and Carole D. Hafner, Indeterminacy: A Challenge to Logic-based Models of Legal Reasoning, in Yearbook of Law Computers and Technology, Volume 3, Butterworths, London, England, 1987. See also Julius Stone, Fallacies of the Logical Form in English Law, in Paul Sayre (ed.) Interpretations of Modern Legal Philosophies, Oxford University Press, New York Inc., New York, U.S.A., 1947, pages 696-735.)
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- (24) O.W. Holmes, Law in Science and Science in Law, 12 Harvard Law Review 443, at 449 ff.(1899)
- 27
- (25) William Green and Sons, Edinburgh and London.
- 28
- (26) Second edition of version edited by Ferdinand Tonnies, Frank Cass and Co. Ltd., London, England, 1969.
- (29) The Structure of Appearance, third edition, D. Reidel Publishing Co., Dordrecht, Holland, 1977.
- (30) The Meaning of Information, Mouton, The Hague, Holland, 1972.
- (31) On Human Communication, second edition, The MIT Press, Cambridge, Massachusetts, 1966.
- (32) Rutgers Journal of Computers, Technology and Law, Volume 8, No.1, 1980, 47-63 at page 55.

- (33) Some Jurisprudential Implications of Electronic Data Processing, in Hans W. Baade (ed.) op. cit. page 69.
- (34) Op. cit. page 20.
- (35) Introduction to Artificial Intelligence, Addison-Wesley Publishing Co., Reading, Massachusetts, 1985, page 6.
- (36) Teleogenic Behaviour Based on Granular Control, in A.A. Martino and F.S. Natali (eds) op. cit. pages 717-734, at page 726.
- (37) Expert Systems in Law. A Jurisprudential and Formal Specification Approach, in A.A. Martino and F.S. Natali, (eds) op. cit., pages 625-642 at page 628.
- (38) In G. Mitra, (ed.) Computer Assisted Decision Making, Elsevier Science Publishers B.V., Amsterdam, Holland, 1986, page 165-174 at page 173.

APPENDIX A

THE CLIMS PILOT
KNOWLEDGE BASE

goal is contract.status

legalanswers are yes no do.not.know *

if offercom is ok
and expired is ok
and consideration is ok
and rejection is ok
and revocation is ok
and request is ok1
and reasonable is ok
then contract.status is NO.INVALIDITY.FOUND

if offercom is ok
and expired is ok
and consideration is ok
and rejection is ok
and revocation is ok
and request is ok2
and reasonable is ok
then contract.status is NO.INVALIDITY.FOUND

if offercom is not.ok
then contract.status is INVALID

if expired is not.ok
then contract.status is INVALID

if consideration is not.ok
then contract.status is INVALID

if rejection is not.ok
then contract.status is INVALID

if revocation is not.ok
then contract.status is INVALID

if reasonable is not.ok
then contract.status is INVALID

if offercom is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if expired is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if consideration is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if rejection is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if revocation is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if request is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

if reasonable is ok.not.ok
then contract.status is RISK.OF.INVALIDITY

question communication is "Has your offer been
communicated to the offeree?"

if communication is yes
then offercom is ok

if communication is no
then offercom is not.ok

question wholly.written is "Is your offer wholly in writing

question partly.Written is "Is your offer partly in writing

question delivered is "Has your written offer been delivered
to the offeree?"

question comprehend.writing is
"Did offeree have opportunity and capability to
comprehend written offer?"

question wholly.oral is "Was your offer wholly in an oral
form?"

question partly.oral is "Was your offer partly in an oral
form?"

question comprehend.oral is "Did the offeree comprehend your
oral offer?"

question Wholly.conduct is "Was your offer wholly by
conduct/body language?"

question partly.conduct is "Was your offer partly by
conduct/body language?"

question comprehend.conduct is "Did offeree comprehend
your conduct/body language offer?"

if communication is do.not.know
and wholly.written is yes
and delivered is yes
and comprehend.writing is yes
then offercom is ok

if communication is do.not.know
and wholly.written is yes
and delivered is no
then offercom is not.ok

if communication is do.not.know
and wholly.written is yes
and delivered is do.not.know
then offercom is ok.not.ok

if communication is do.not.know
and wholly.written is yes
and delivered is yes
and comprehend.writing is no
then offercom is not.ok

if communication is do.not.know
and wholly.written is yes
and delivered is yes
and comprehend.writing is do.not.know
then offercom is ok.not.ok

if communication is do.not.know
and wholly.written is do.not.know
then offercom is ok.not.ok

if communication is do.not.know
and wholly.written is no
and partly.written is yes
and delivered is yes
and comprehend.writing is yes
and partly.oral is yes
and comprehend.oral is yes
and partly.conduct is yes
and comprehend.conduct is yes
then offercom is ok

if communication is do.not.know
and wholly.written is no
and partly.written is yes
and delivered is yes
and comprehend.writing is yes
and partly.oral is no
and partly.conduct is yes
and comprehend.conduct is yes
then offercom is ok

if communication is do.not.know
and wholly.written is no
and partly.written is yes
and delivered is yes
and comprehend.writing is yes
and partly.oral is yes
and comprehend.oral is yes
and partly.conduct is no
then offercom is ok

if communication is do.not.know
and partly.written is no
and wholly.oral is no
and partly.oral is yes
and comprehend.oral is yes
and partly.conduct is yes
and comprehend.conduct is yes
then offercom is ok

if partly.written is do.not.know
then offercom is ok.not.ok

if partly.written is yes
and delivered is no
then offercom is not.ok

if partly.written is yes
and delivered is yes
and comprehend.writing is no
then offercom is not.ok

if wholly.written is no
and partly.written is yes
and delivered is do.not.know
then offercom is ok.not.ok

if wholly.written is no
and partly.written is yes
and delivered is yes
and comprehend.writing is do.not.know
then offercom is ok.not.ok

if partly.written is no
and wholly.oral is yes
and comprehend.oral is yes
then offercom is ok

if Wholly.written is no
and partly.written is no
and wholly.oral is yes
and comprehend.oral is no
then offercom is not.ok

if partly.written is no
and wholly.oral is yes
and comprehend.oral is do.not.know
then offercom is ok.not.ok

if partly.written is no
and wholly.oral is do.not.know
then offercom is ok.not.ok

if partly.written is yes
and delivered is do.not.know
then offercom is ok.not.ok

if partly.written is yes
and delivered is yes
and comprehend.writing is yes
and partly.oral is do.not.know
then offercom is ok.not.ok

if partly.oral is do.not.know
then offercom is ok.not.ok

if partly.oral is yes
and comprehend.oral is no
then offercom is not.ok

if partly.oral is yes
and comprehend.oral is do.not.know
then offercom is ok.not.ok

if partly.written is no
and partly.oral is no
and wholly.conduct is yes
and comprehend.conduct is do.not.know
then offercom is ok.not.ok

if partly.written is no
and partly.oral is no
and wholly.conduct is do.not.know
then offercom is ok.not.ok

if partly.written is yes
and partly.oral is no
and partly.conduct is no
then offercom is not.ok

if partly.written is no
and partly.oral is yes
and partly.conduct is no
then offercom is not.ok

if partly.written is no
and partly.oral is no
and partly.conduct is yes
then offercom is not.ok

if partly.conduct is no
and partly.oral is no
and partly.written is no
then offercom is not.ok

if communication is do.not.know
and wholly.written is no
and partly.written is no
and wholly.oral is no
and partly.oral is no
and wholly.conduct is yes
and comprehend.conduct is yes
then offercom is ok

if partly.oral is no
and wholly.conduct is yes
and comprehend.conduct is no
then offercom is not.ok

if partly.conduct is yes
and comprehend.conduct is no
then offercom is not.ok

if partly.conduct is yes
and comprehend.conduct is do.not.know
then offercom is ok.not.ok

if partly.conduct is do.not.know
then offercom is ok.not.ok

question consider is
"Does offer provide for exchange of
consideration between you and offeree?"

if consider is yes
then consideration is ok

if consider is no
then consideration is not.ok

if consider is do.not.know
then consideration is ok.not.ok

question has.expired is "Has your offer expired?"

question time is
"Did your offer stipulate a time period for
acceptance?"

question reasonable.time is
"Has a reasonable time elapsed
since the offer was communicated?"

if has.expired is yes
then expired is not.ok

if has.expired is no
then expired is ok

if has.expired is do.not.know
and time is no
and reasonable.time is yes
then expired is not.ok

if has.expired is do.not.know
and time is no
and reasonable.time is do.not.know
then expired is ok.not.ok

if has.expired is do.not.know
and time is do.not.know
then expired is ok.not.ok

if has.expired is do.not.know
and time is no
and reasonable.time is no
then expired is ok

question period.has.expired is
"Has the stipulated time period in
the offer elapsed?"

if has.expired is do.not.know
and time is yes
and period.has.expired is yes
then expired is not.ok

if time is yes
and period.has.expired is no
then expired is ok

if time is yes
and period.has.expired is do.not.know
then expired is ok.not.ok

question revoke is "Have you legally revoked your offer?"

if revoke is yes
then revocation is not.ok

if revoke is no
then revocation is ok

question communicated.revocation is
"Have you communicated to the offeree a
withdrawal of your offer?"

if revoke is do.not.know
and communicated.revocation is yes
then revocation is not.ok

question third.party is
"Has a third party communicated to
the offeree your withdrawal of offer?"

if revoke is do.not.know
and communicated.revocation is no
and third.party is no
then revocation is ok

if revoke is do.not.know
and communicated.revocation is no
and third.party is yes
then revocation is not.ok

if revoke is do.not.know
and communicated.revocation is no
and third.party is do.not.know
then revocation is ok.not.ok

if revoke is do.not.know
and communicated.revocation is do.not.know
then revocation is ok.not.ok

question reject is
"Has your offer been rejected
by the offeree?"

if reject is yes
then rejection is not.ok

if reject is no
then rejection is ok

question refuse is
"Has offeree made any of:counter-offer/
refusal/qualified acceptance?"

if reject is do.not.know
and refuse is yes
then rejection is not.ok

if refuse is no
then rejection is ok

if refuse is do.not.know
then rejection is ok.not.ok

question particularize is
"Have you received a request for further
details of offer from offeree?"

if reason is unknown
and particularize is yes
then request is ok1

if reason is yes
and particularize is yes
then request is ok1

if particularize is no
then request is ok2

if particularize is do.not.know
then request is ok.not.ok

question reason is
"Would a reasonable person in offeree's position
assume you made an offer?"

if reason is yes
then reasonable is ok

if reason is no
then reasonable is not.ok

if reason is do.not.know
then reasonable is ok.not.ok

answer is "The status of your contract is "contract.statu

APPENDIX B

INSTRUCTIONS FOR USE
OF CLIMS PILOT

INSTRUCTIONS FOR USE OF CLIMS PILOT

1. Boot up.
2. Have cursor ready in drive where Clims Pilot is inserted.
3. Type: ESIE
4. First screen of ESIE will be displayed. Type name:
CLIMS.OFF
5. ==> will appear. Commands may be entered as follows:

```
go
trace on
trace off
exit
```

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