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LOGICAL STRUCTURE OF LAW AND THE POSSIBILITY OF COMPUTER AIDED LEGAL REASONING*

By Hajime Yoshino

1. Introduction

Computers and new communication systems combined with computers have been applied in various human intellectual activities. These applications will doubtless continue to expand. It should not be surprising, therefore, that computers should find application in the field of law as well.

When one hears of using computers in the legal field, one can imagine that its most beneficial application might be to reason out the conclusion of law application. If a computer can be used to do this, then it cannot be denied that such a system would be useful as an adjunct to legal practice. Learning legal science means knowing laws and acquiring the art of legal reasoning, so such a system might also be helpful in legal education. Therefore, the necessity of constructing such a system is evident and compelling.

The development of logic in this century and of a new linguistic theory based on it has opened wider the possibility of scientific research into human thought processes. In the field of law, too, legal logic, born as an application of modern mathematical logic, has begun to be employed in analyzing the logical structure of law and legal reasoning in detail. If the logical structures can be clarified, computers can be effectively applied to legal reasoning in the process of application of law.[1] This research aims at clarifying the fundamental logical structure of law and legal reasoning from the point of legal logic. Further, this research aims to develop and present a laboratory legal reasoning system in contract law so as to estimate and also demonstrate the possibility of computer aided legal reasoning in the process of the application of a law.

* This contribution is developed from my Japanese paper presented in the Law and Computers, No. 3 June 1985, pp. 77–94, which was an outline of the result of my joint project "Logical Analysis of Law and Study on a Possibility of Application of Computers to Judicial Process by Way of Building a Laboratory System – Concentrating on Contract of Sale –". The research project was supported by GRANT IN AID FOR SCIENCE RESEARCH of the Ministry of Education, 1983 (Research Report Project N. 57450043). The research report was published in Japanese with the same title in 1984.

1 The research of an application of computers to legal reasoning has been rarely tried. For one of the few such efforts in Japan see, Tohoku University, Faculty of Law, Information Science Association, "The Processing of Inheritance Problems by Electronic Calculator" Jurist No. 397; 401; 403; 405; 407, 1968. In U.S.A. cf. TAXMAN at Rutgers University; in U.K. cf. *Cory*, H. T., *Hammond*, P., *Kowalski*, R. A., *Kriwaczek*, F., *Sadri*, F., *Sergot*, S., The British Nationality Act as a Logic Program, London 1984.

2. Methodological Presupposition of This Research

Computers presuppose logical rules. It is, therefore, necessary that logical rules be applicable to legal reasoning and that legal reasoning be formulated by means of logic, so that computers may be utilized.

A law is a norm. Since a norm prescribes what a person ought to and ought not to do, it can be separated from the propositions of natural science and general sociology in that the former is composed of norm sentences. In the world of legal logic the following argument was influential.[2] Classical mathematical logic based on the concept of truth and its rules mathematical logic are not applicable to legal norms because while it is meaningful that a proposition be true or false, it is meaningless to speak of a norm as being true or false.

It can be said, however, that mathematical logic may be directly applied to legal norms. In application there is no theoretical difficulty. This can be done by basing it on a formal semantical definition of the truth concept of logic. (This argument was dealt with in a previous paper by Yoshino.[3])

There is a widely held pessimistic view that no logical relation exists between legal norms established by legislators and legal decisions by judges because the meaning of legal norm is based on the willing-act of the legislators. Once the meaning of rules, however, is settled, it exists independently of the legislator himself.[4] It appears only in the consciousness of the judge, who is an interpreter of the rule in applying a law. In as much as a judge must make a decision consistent with the legal norms, logical rules can be applied to the process of the law application.[5]

There is also another view that a judgement as a concrete legal norm can not be logically deduced from an abstract legal norm. This argument can be supported as far as it is concerned with direct logical deduction of a judgement from laws. But there are interpritive propositions, which concretize law and create a bridge between abstract law and concrete cases in the process of law application. If these are added to law as premises, then legal decisions are actually deduced logically from all the premises, i.e. law with interpretive propositions. This argument will be dealt with in chapter 4.

As mentioned above, there is not any theoretical difficulty for classical logic to be applied to reasoning in the process of law application.

2 Weinberger was the representative of this view. Vgl. *Weinberger*, O., Rechtslogik, S. 189–195; *ders.*, Bemerkungen zu J. Rödig's "Kritik des normlogischen Schließens," in: Theory and Decision 3, S. 311–317. Auch vgl. *Wagner*, H. u. *Haag*, K., Die moderne Logik in der Rechtswissenschaft, 1970, S. 81–84.

3 *Yoshino*, H., Über die Notwendigkeit einer besonderen Normenlogik als Methode der juristischen Logik, in: *Klug* u.a. (Hrsg.), Gesetzgebungstheorie, Juristische Logik, Zivil- und Prozeßrecht, 1978, S. 40 ff.; *ders.*, Zu Ansätzen der Juristischen Logik, in: *Tammelo*, I. u. *Schreiner*, H. (Hrsg.), Strukturierungen und Entscheidungen im Rechtsdenken, 1978, S. 283 ff.; *ders.*, Zur Anwendbarkeit der Regeln der Logik auf Rechtsnormen, in: Die reine Rechtslehre in der wissenschaftlichen Diskussion, 1982, S. 142 ff.; *Yoshino*, Legal Logic – Direct Application of Mathematical Logic to Legal Norms (in Japanese), in: *Nagao/Tanaka* (eds.), Modern Legal Philosophy, Vol. 1, Tokyo Univ. Press 1983, pp. 216 f.

4 Kelsen is said to have insisted this to be true in his later years. *Kelsen*, H., Allgemeine Theorie der Normen, 1979, S. 152.

5 *Yoshino*, H., Zur Anwendbarkeit der Regeln der Regeln der Logik auf Rechtsnormen, in: Die reine Rechtslehre in wissenschaftlicher Diskussion, 1982, S. 162 f.

3. The Concept of Legal Norm Sentence

First of all, I think I have to define the concept of "legal norm sentence," which forms the basis of this research.

This research starts with the legal concept of "norm sentence." A legal norm sentence is a linguistic expression of legal norm, which consists in the meaning of a legal norm sentence. Whereas legal norm sentences exist, the legal norm itself does not exist. It only appears in the consciousness of the person who establishes, reads, or interprets the legal norm sentences.[6]

Legal norm sentences can be basically separated into two types, that is, the primary legal norm sentence and the secondary one. The former describes directly the world of normative duty. The latter decribes the validity requirements of the primary legal norm sentence. The former can be called an "object legal norm sentence," and the latter a "meta legal norm sentence." The legal norm sentence, which regulates the validity of the secondary legal norm sentence, is the secondary legal norm sentence of the secondary legal norm sentence.

All legal norm sentences have the structure of conditional sentences. The antecedent of the conditional sentence is a legal requirement, and the consequent a legal effect. In the primary legal norm sentence, the antecedent finally describes certain social affairs and the consequent a certain obligatory relation. There are also intermediate legal norm sentences mediating between the final legal requirement and the final legal effect. In these, certain normative affairs may turn into legal requirements or legal effects. The legal effect of the secondary legal norm sentence describes the change of the validity of the legal norm sentence, that is, its formation, its change and its dissolution.

Considering contract law from the above viewpoint, the contract itself is the primary legal norm sentence. The legal norm sentence of contract law, which prescribes the formation, the change and the dissolution of its effect, is the secondary legal norm sentence.

In describing the change of the validity, the secondary legal norm sentence usually distinguishes the formation requirement from the validity requirement. That a legal norm sentence is formed means that the sentence is created in the form of a legal norm sentence, and that a legal norm sentence is valid means that the legal norm sentence is affirmately estimated as a true proposition belonging to the legal system.[7] The former is the prerequisite of the latter. That is, only when a legal norm sentence is formed as such, it can be estimated whether it is valid.

As a requirement of validity a negative requirement and a positive one can be thought of. The former is satisfied when there is no cause denying the validity, for example violation of imperative laws. The latter is a requirement for legal norm sentence to become effective, such as the time or the condition of effectuation of legal norm sentences. The secondary legal norm sentence also describes the extent of the validity of the primary legal norm sentence, the extent being set by temporal, locational and personal standards.

6 Ebenda.

7 In the author's opinion, the validity or the effect of legal norm sentences should be regarded as truth values from the point of view of logic. Cf. *Yoshino*, Legal Logic (supra note (3)) pp. 222 f.; Justice and Logic – The Role of Deductive Methods in Reasoning about Justice (in Japanese), in: Justice, The Annual of Legal Philosophy 1974, p. 52. Auch vgl. *Yoshino*, H., op. cit., Anmerkung (5), 153 ff.

From the viewpoint of a legal sentence, the legal relation is the meaning of the legal norm sentence. That is, the legal relations constitute the world of normative meaning expressed by a legal norm sentence. It describes the "state" of a certain obligatory relation of social life. A legal relation exists if a legal norm sentence expressing the relation has the legal validity as such.

Therefore, if the aim of legal reasoning is to determine the existence of legal relations, it is sufficient to determine that the very legal norm sentence exists, i.e., that the very legal norm sentence has the validity.

In a logical analysis of contract law, it is impossible to avoid the concept of a juristic act. A juristic act, I believe, should be understood as a legal norm sentence. The formation of a juristic act and its effect corresponed to that of a legal norm sentence and to its validity. Accordingly, when a juristic act is null, for instance, the legal norm sentence in question is negatively estimated. "The nullity cannot be set up against a bona fide third party," which means that the validity (or its change) of the legal norm sentence does not affect the third.

4. Logical Structure of Reasoning in Application Process of Law

Legal reasoning in the judicial process can be studied from two aspects, i.e. from the standpoint of the reasoning of justification of a legal conclusion and from the standpoint of the reasoning to find the conclusion itself. The former can be called the "reasoning of the legal justification," and the latter the "reasoning of legal decision (or legal discovery)." Here I intend to deal with the former only. For itis looked upon as the fundamental framework for reasoning in the law application process.[8]

The logical structure of justification in law application is said to be based on the syllogism of traditional logic by the traditional general theory of law and legal methodology.[9]

This type of reasoning can be formulated by the following example in relation to § 204 of the Penal Code of Japan.

(1) Major Premise: Law: "Any person who inflicts an injury upon the person of another, shall be punished with penal servitude for not more than ten years or a fine of not more than five hundred yen, or a minor fine."

(2) Minor Premise: Fact: "A is a person who inflicted an injury upon the person of another."

(3) Conclusion: Legal Decision: "A shall be punished with penal servitude for not more than ten years or a fine of not more than five hundred yen or, a minor fine."

8 In finding legal decision, it is necessary to reason considering justification of the legal decision. For the reasoning involved in legal discovery, see *Yoshino*, H., Logical Structure of Reasoning leading to Legal Decision (in Japanese), in: Essays in celebration of the 125th Anniversary of Establishment of Keio Gijuku (Association for the Study of Law and Politics, Legal Section), pp. 3 f.; *ders*, Die logische Struktur der Argumentation bei der juristischen Rechtstheorie Beiheft 2. 1979, S. 235 ff.

9 For instance, vgl. *Heck*, Ph., Gesetzesauslegung und Interessenjurisprudenz, 1914, S. 89, Neudruck in: *ders*., Das Problem der Rechtsgewinnung, Gesetzauslegung und Interessenjurisprudenz, Begriffsbildung und Interessenjurisprudenz, Bad Homburg v. d. Höhe–Berlin–Zürich 1968, S. 83; *Biering*, E. R., Juristische Prinzipienlehre IV, Neudruck Aalen 1961, S. 7 f.; *Binder*, J., Rechtsbegriff und Rechtsidee, Leipzig 1915, S. 260 ff., *Somio*, F., Juristische Grundlehre, Leipzig 1917, 2. Aufl. 1927, S. 395; *Sauer*, W , Juristische Methodenlehre, Stuttgart 1940, Neudruck Aalen 1970, S. 11, u. 560.

This inference is, of course, logically valid as a Barbara-type syllogism. But this does not always properly express the structure of reasoning in law application in the following ways: first of all, it does not properly express the facts; and secondly it can not capture the role of interpretations of legal rules in law application.[10] As for the former, the actual state of affairs occurred in a concrete situation is, for example, such a concrete situation that A knocked a person down and kicked his/her chest so that he/she felt pain in the chest for ten days. The proposition, "A is a person who inflicted an injury upon the person of another" would, thus, express legal value judgement that is concluded through legal reasoning on the basis of such concrete facts.

This process has been referred to as "subsumption."[11] In this subsumption process, it is necessary that law should be interpreted for "concretization"[12] of the law that builds a logical bridge between the abstract law and the concrete facts. By adding the proposition formulated by the interpretation – the interpretive proposition – to the legal rule, the process of reasoning for justification in law application can be expressed in the following scheme.[13]

(1) Law: "Any person who inflicts an injury upon the person of another, shall be punished with penal servitude for not more than ten years or a fine of not more than five hundred yen, or a minor fine."

(1a) Interpretive Proposition of Law: "A person who inflicts an injury upon the person of another is one who has caused him/her an impediment of physiological function."

(1b) Supplementary Interpretive Proposition: "To cause an impediment of physiological function involves making his/her health condition unwholesome in general."

(2a) Subsumption of a Situation of Fact into Interpretive Proposition: "To knock a person down and give a kick to his/her chest to that he/she feels a pain in the chest for ten days is to make his/her health condition unwholesome."

(2b) Fact: "A has knocked B down and given a kick to his/her chest so that he/she might feel a pain in the chest for ten days."

(3) Legal Decision: "A shall be punished with penal servitude for not more than ten years or a fine of not more than five hundred yen, or a minor fine."

The general logical structure of reasoning for legal justification in the above mentioned example can be expressed in the following way by using predicate logic:[14]

10 Vgl. *Yoshino*, H., Die logische Struktur der Rechtfertigung in der rechtlichen Entscheidung (in Japanese), The Meiji Gakuin Law Review, 26, 1980, pp. 91–92.

11 Vgl. *Engisch*, K., Einführung in das Juristische Denken, 5. neu bearbeitete Aufl., 1956, S. 55 f., *Larenz*, K., Methodenlehre der Rechtswissenschaft, 3. Aufl., S. 255.

12 Cf. *Yoshino*, ibid. note (10), pp. 93 ff. Auch vgl. *Engisch*, K., Logische Studien zur Gesetzesanwendung, 2. Aufl., 1960, S. 16 ff.; *Rödig*, J., Die Theorie des gerichtlichen Erkenntnisverfahrens, 1973, S. 163–184.

13 This reasoning schema is based on an actual legal decision (cf. The Decision of the Third Petty Bench of the Supreme Court, 22rd April, 1957). Criminal Precedent vol. 11, p. 1393.

14 For this logical structure model of reasoning of justification in law application, cf. *Yoshino*, ibid. note (10), p. 115. I presented the model in law application. Cf. *Yoshino*, ibid. note (10), p. 115. I presented the model in the international symposium "Structuring and Decision Problem in Legal Thought" in Salzburg, November 1976. It was also published in: *Yoshino;* H., Zu Ansätzen der

(1) Law: $\forall x(Tb(x) \rightarrow Rf(x))$
(1a) Interpretive Proposition of Legal Rule: $\forall x(Tb1(x) \leftrightarrow Tb(x))$
(1b) Supplementary Interpretive Proposition: $\forall x(Tb1.1(x) \rightarrow Tb1(x))$
(2a) Subsumption of a Situation of Fact into Supplementary Interpretive Proposition. $\forall x(Sv(x) \rightarrow Tb1.1(X))$

(2b) Fact: $Sv(a)$

(3) Legal Decision: $Rf(a)$

Therefore, from law (1), interpretive proposition (1a) and supplementary interpretive proposition (1b), subsumption of a situation of a concrete fact into interpretive propositon (2a) and fact (2b), legal decision (3) could be logically deduced. In this sense, justification in law appliction is amenable to logical reasoning.

Further, in the above model of logical formulas the whole of the law and interpretive propositions is regarded as "a concrete legal norm (sentence) being truly valid" in the society in question and at the time in question.

An application of computer to reasoning of justification in law application, thus, means making a computer reason how a legal decision in a certain case can be justified under the related legal norm sentences. In order to reason in this way, a computer system is premised; that is, the related legal norm sentences are put into the computer in advance. The user puts in the data of a given case and can, using the computer, reason the conclusion of law application to the case if the user is given a case. For reasoning of justification in law application by a computer, the computer must be provided with a system of the related legal norm sentences as input knowledge-data and the reasoning system uses that knowledge-data. For this purpose, it is necessary that the logical structure of the related legal norm sentences and their mutual relations be specified.

5. Logical Structure of Legal Norm Sentences

The logical structure of a unit legal norm sentence consists in a combination of the legal requirement and legal effect. The relation obtains that when the former has been met, the latter comes to occur. The combination of goth is a logical one. In other words, the legal norm sentence has the logical structure that the legal requirement is the antecedent and the legal effect is the consequent: these can, therefore, be combined with logical operators, i.e., implication ("if": "→"), contra-implication ("only if" : "←"), equivalence ("if and only if" : "↔"). Denoting the legal requirement by V and the legal effect by F, the logical structure of legal norm sentences can be expressed as three types of logical propositions.

(1) $V \rightarrow F$: (if V, then F)
(2) $V \leftarrow F$: (only if V, then F)
(3) $V \leftrightarrow F$: (if and only V, then F)

Juristischen Logik, in: *Tammelo*, I., u. *Schreiner*, H., (Hrsg.), ebenda, S. 283. At almost the same time, Alexey presented a similar model; *Alexey*, R., Theorie der juristischen Argumentation, 1978, S. 219.

In type (1), V is a sufficient condition for F; in type (2), V is a necessary condition for F; in type (3), V is a necessary and sufficient condition for F. Replacing V with F in type (2), (2) is reduced to type (1). Type (2) is logically equivalent to the following:

(4) $\sim V \rightarrow \sim F$

Type (1), (2) and (3) can be respectively expressed by logic flowcharts (Figure 1).[15]

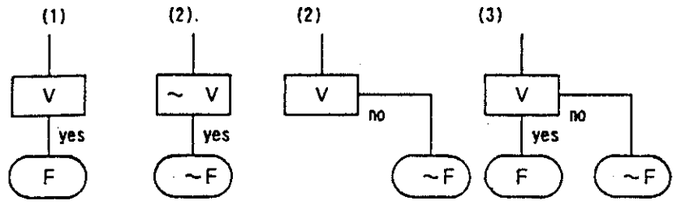

Figure 1. Fundamental logical structure of a unit legal norm sentence

The legal requirement can be analyzed into its legal requirement factors. The legal requirement factors, which are logically combined with each other, constitute one (unit) legal requirement that is combined with one legal effect. They are logically combined by the logical operators: conjunction ("and" : " · ") and disjunction ("or" : " ∨ "). When the factors are of the legal requirement V1, V2, V3, the logical structure of the legal requirement results in three types (7), (8) and (9). The logical formulas correspond to the following logic flowcharts in Figure 2:

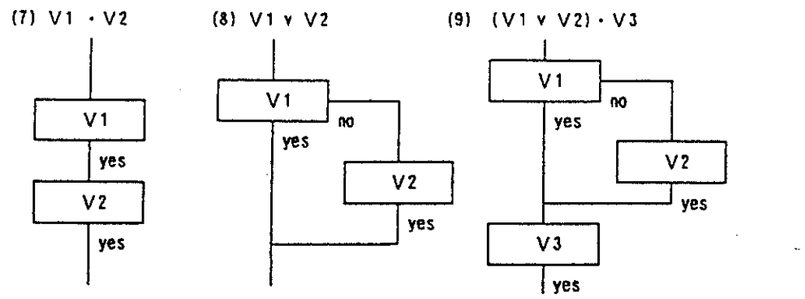

Figure 2. The inner logical structure of a legal requirement

Different legal norm sentences may have the same legal effect. In this case these legal norm sentences can be subsumed into one sentence by combining their legal requirement

15 Type (1) is the fundamental formula of legal norm sentence, and type (3) is the complete formula. Even if individual legal norm sentences are type (1), they may be combined to the form type (3). See Figure 4, (15) and (16).

factors. This principle may be expressed by the following logical formulas and logic flowcharts (Figure 3):

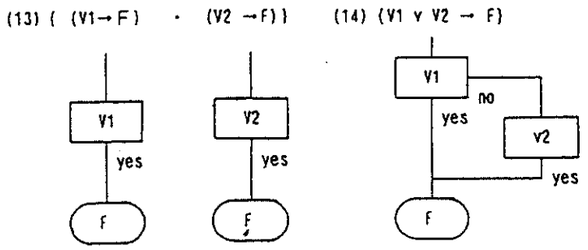

Figure 3. The logical structure of a parallel combination of a legal norm sentence

If all the legal norm sentences with the same legal effect are combined completely, in other words, if there are no other legal requirements combined with the legal effect in question, then the combination of the legal requirement with the legal effect lies in the logical relation equivalence. If as the legal norm sentences having the legal effect F, there are only two sentences i.e., "V1 → F" and "V2 → F," for example, then that relation can be expressed by the following logical formula and logic flowcharts the coexistence of these two norms is (13), so equal to (14)) and the legal norm sentence limiting the requirement for F to V1 and V2 is "~ (V1 v V2) → ~ F" (see (2), (4)). So, these two lead to (16) (Figure 4).

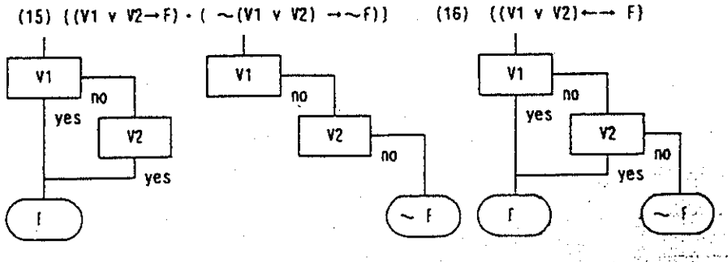

Figure 4. From the fundamental formula of legal norm sentence to a complete formula

The law has a hierarchical systematic structure, in which more abstract concepts involve legal concepts with more concrete contents and more abstract concepts are concretized by more concrete concepts. This is also the case with the combination of legal norm sentences. More concrete legal norm sentences are integrated by a more abstract legal norm sentence, and the latter is much concretized by the former. The principle for integrating legal norm sentences which have a different degree of abstraction (or concretion, as is the same meaning) lies in the definition of a rule. Namely, two legal norm sentences are combined with each other by the logical operator for equivalence "↔". When a more abstract legal requirement factor V1 consists of more concrete legal factors V1.1

and V1.2 and V1.1 is further concretized by V1.1.1 and V1.1.2, then the logical formulas and logic flowchart will be expressed as in Figure 5.[16]

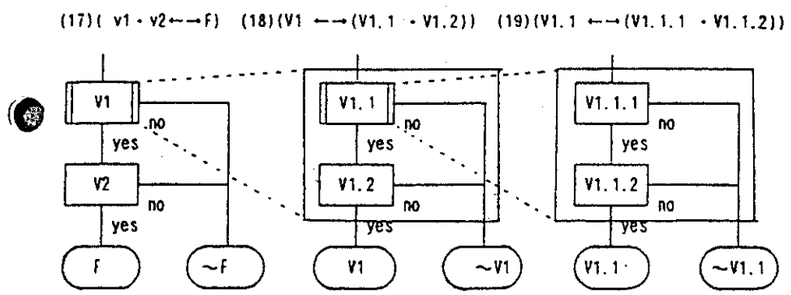

Figure 5. The logical structure of hierarchical connection of legal norm sentences

In Figure 5 below, the relation between (17) and (18) as well as (18) and (19) may well be called a main-sub, or parent-child relation. That is, (17) is parent of (18), and (18) is child of (17). The same thing can be said for (18) and (19). Namely, (18) is parent of (19).

6. The Fundamental Structure of a Legal Reasoning System

On the basis of what has been presented in the foregoing chapters, it is possible to construct a small laboratory system which applies computers to reasoning out the conclusion in applying a legal norm to a given case. Our project has analyzed the logical structure of legal norm sentences relating to the formation and the becoming effective of sale,[17] and constructed a reasoning system on a personal computer PC 8800.[18] In this chapter the fundamental structure of the system will be described.[19]

When the system starts, the page "operating entry" appears on the display (Figure 6). The functions and the whole structure of the system are described on the page.

16 The hierarchical relation expressed in the figure also corresponds to the relation between legal rule (1), interpretive proposition of legal rule (1a) and supplementary interpretive proposition (1b), described in chapter 4.
It goes without saying that the hierarchical relation lies between legal rules.

17 There can be various fields of law which are the research object, but this research concentrated on contract law, for it is one of fundamental laws, involving complex logical structure and abundant hierarchy between the legal rules as well. Such a system has various applications.

18 This research built the legal reasoning system, but the fundamental principles and conception of the system had already presented in the following paper: *Yoshino*, H., Possibility of Applying Computers to Judicial Process, (the prize paper of The YOMIURI Newspaper Company). The YOMIURI, evening edition, 22nd December 1983, page 9.

19 The program of the system was produced by professor Osamu Ide at Meiji Gakuin University. In the program, BASIC is used for basic frame, and assembler for the details. The program is omitted owing to limited space here.

OPERATING ENTRY

0. Explanation of system

1. Reasoning of the conclusion of law application to case

2. List of recorded reasoning process(Run·Update·Print·Delete)

3. Auxiliary function

CHOOSE ENTRY NUMBER

Figure 6. Operating entry of system

Here, only the function and the structure of the operating entry 1, "reasoning of the conclusion of law application to case," will be sketched.

The purpose of reasoning is to predict the legal conclusion which comes from the application of law to a given case. It attempts to determine the legal relationship applicable to the parties of a given case at a given time. The whole structure of the reasoning system is described in Figure 7. This system is planned to consist of input of case data, the linkage of three independent partial decision systems, *creation of legal relation, dissolution of legal relation,* and *modification of legal relation.*

In reasoning, it is first determined whether a legal relation obtains in a given case or not. In this system, first of all, the creation of a legal relation is determined which is combined with satisfaction of a single legal requirement (Figure 7, 2–4).

The determination of the creation of a legal relation itself is not enough to ensure that the legal relation does exist. The fact that a legal relation exists means that the legal relation is created and it has not disappeared. In order to determine the existence of a legal relation, the dissolution of the created legal relation must be examined. Accordingly, the system of dissolution of a legal relation follows (Figure 7, 5–7). If the dissolution is determined, the information will be stored and described on the final display.

If the absence of the dissolution is determined, then it must be determined whether the legal relation is modified or not. Accordingly, the system of the modification of legal

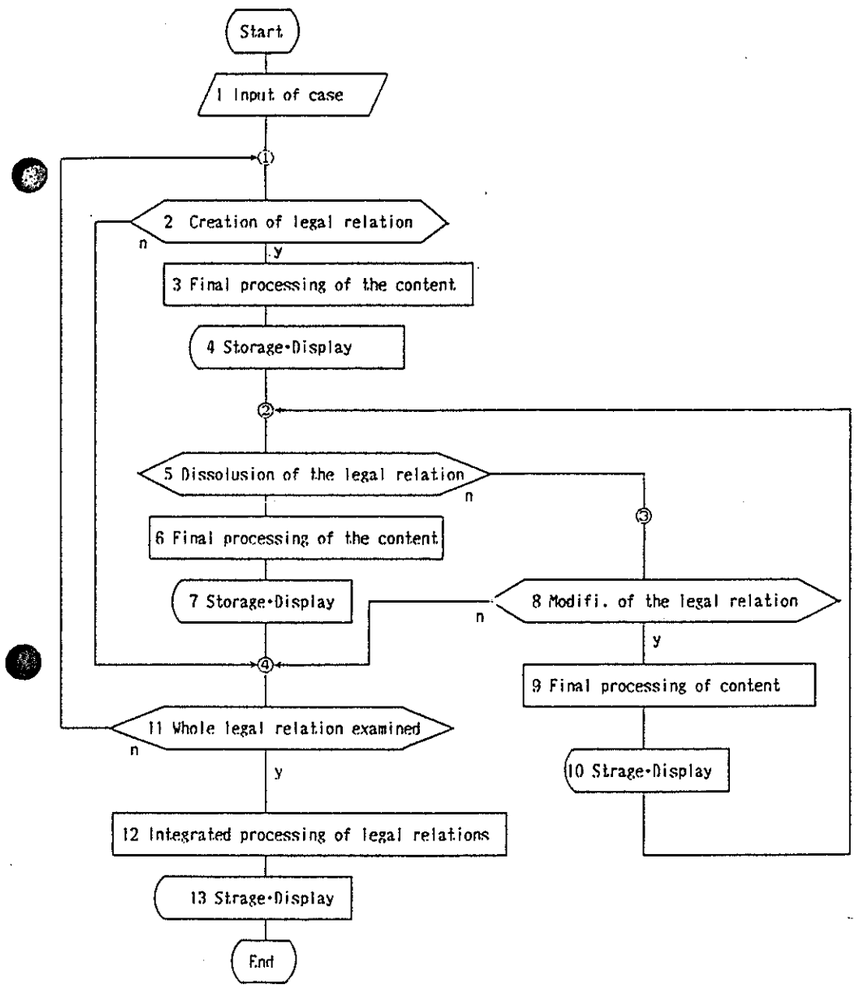

Figure 7. Overall structure of the reasoning system

system follows (Figure 7, 8–10). If the legal relation is not modified, the created legal relation continues to exist as it did when it was created. If there is any modification, the content of the modification will be determined.

As the existence of a legal relation created in connection with satisfaction of the single legal requirement has been determined, it will be necessary to investigate whether a legal relation exists or not which should be created in connection with satisfaction of any other legal requirement (Figure 7, 11). If it can be shown that other legal requirement exists, reasoning will be started again from the system of creation of legal relation (Figure 7, 2–4). And the above mentioned procedures will be repeated.

If all possible changes of legal relation in the case in question are determined in this way, all the stored legal relations are completely described (Figure7, 11–12). By this procedure reasoning comes to an end.

Now, the process of reasoning by computer in each reasoning system of *creation of legal relation, dissolution of legal relation,* and *modification of legal relation* will be sketched.

This reasoning system stores legal norm sentences and their logical combinations in the form of a flowchart. The logic flowchart is shown on the CRT display, and according to

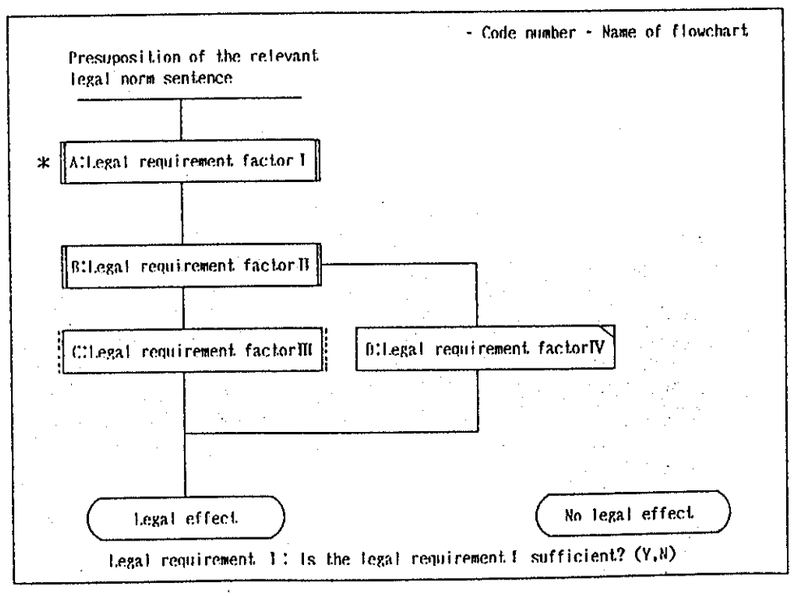

Figure 8. The model of logic flowchart of the system

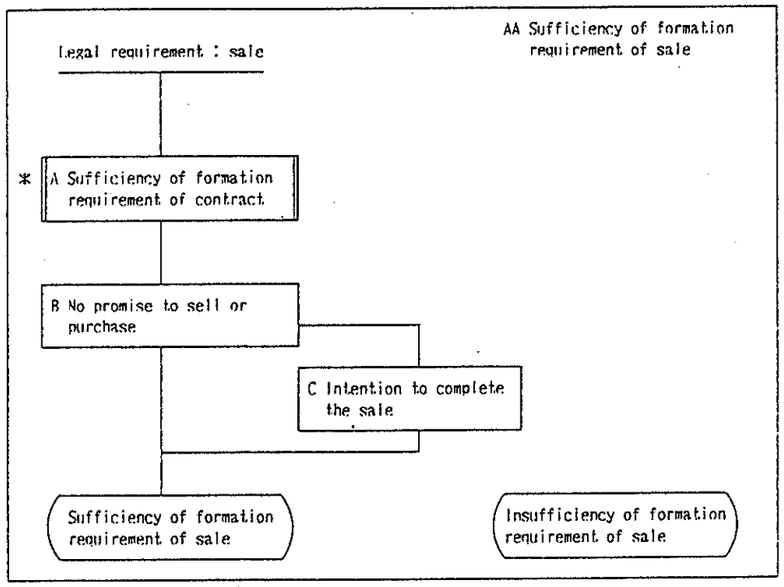

Figure 9. Example of logic flowchart of legal norm sentence (parent)

the flow of a logical circuit, the computer reasons through to the conclusion applying to the law to a case in the way that a user answers the question expressed at the bottom of the display. Each display describes a unit of legal requirement-effect, which expresses one or more legal norm sentences. As far as all the legal norm sentences have the same legal effect, they are collectively described in one display. The logical principles constituting a logic flowchart have been already clarified in section five above.

The logic flowchart for a legal norm sentence of this system is built up in the same way as expressed in Figure 8. Therefore, the way of reasoning with a logic flowchart will be explained below by using Figure 8. First, when a logic flowchart appears on a CRT disply, an asterisk (*) blinks on and off on the left side of _____. This logic flowchart is executed by pushing the RETURN key. In case this logic flowchart is not executed, after pushing the CONTROL key and B key (^ B), the display goes back to the former flowchart. If the RETURN key is pushed, the * goes on and off on the left side of ▭ "A: legal requirement factor I". At the same time, the following question appears at the bottom of the display: "legal requirement factor I: Is the legal requirement factor I satisfied? (Y, N)". Ready to answer to this queston, the user uses the the Y or N key. If not ready to answer, he pushes E key, as the frame ▭ shows there exists a child logic flowchart. Then the display transfers to the child logic flowchart.

The executing procedure of the child logic flowchart is the same as that of the main logic flowchart. The child logic flowchart may have a child (grandchild) flowchart. When

the user obtains a conclusion by executing the child logic flowchart, the page comes back to the main logic flowchart from the child logic flowchart after pushing the RETURN key, and to the left of the frame Y is indicated when the answer is affirmative, N being indicated when the answer is negative. And * moves to the next step of reasoning. That is, when the user chooses Y, * blinks on and off to the left of the frames of the legal requirement factor, which are vertically joined in a solid line, and when the user chooses N, * blinks on and off to the left of the frames, which are horizontally joined. Where a legal requirement factor has no horizontal line and a user chooses N, * jumps to non-creation of legal effect, which means a negative conclusion. The solid line jumping to the negative conclusion is here omitted to avoid complexity. If the user continues this procedure, * finally reaches either "legal effect", an affirmative conclusion, or "no legal effect", a negative conclusion. It is indicated by * blinking on and off to the left of ( ). Thus, the reasoning of this flowchart comes to an end. By pushing the RETURN key, the procedure moves to the next stage. Further, when the logic flowchart in question is the child type, the procedure goes to the next step in the main logic flowchart ___ if any procedure remains, it goes to the next continuing logic flowchart.

The above procedures are for example described in Figures 9–12.

These figures show an example in which "AAA Satisfaction of formation requirement of contract" (Figure 10) isbeing executed and express parent-child relations of logic flow-

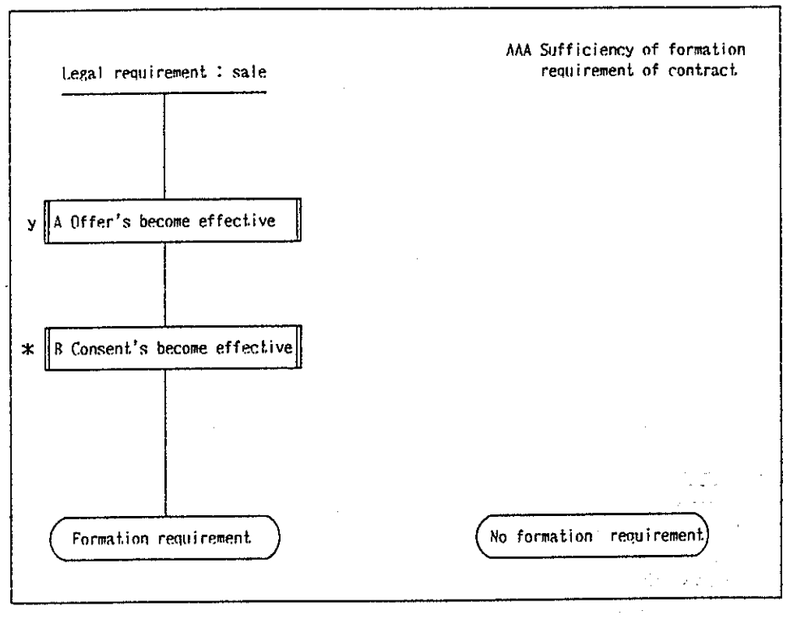

Figure 10. Example of logic flowchart for legal norm

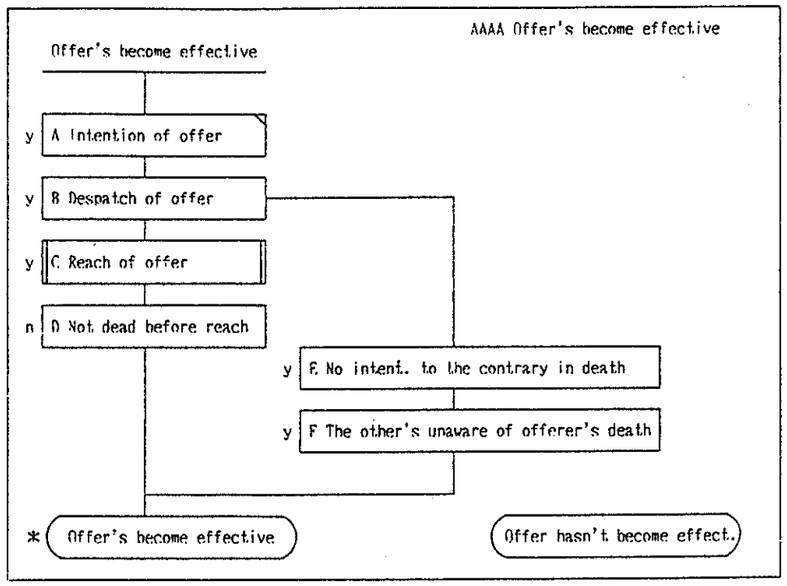

Figure 11. Example of logic flowchart of legal norm sentence (child 1)

charts and reasoning relations. Figure 9 is the parent of Figure 10; Figures 11 and 12 are children of Figure 10. At present, reasoning is running at the stage of relevancy judgement of "A Satisfication of formation requirement of contract" in the flowchart "AA Satisfaction of formation requirement of sale" (Figure 9) – it is indicated by a flashing *_____ and on the CRT display now appears "AAA Satisfaction of formation requirement of contract", which is a child logic flowchart of Figure 9. In this Figure 10, Y lies to the left of "A Offer's become effective," the first legal requirement factor, which shows an affirmative answer in judging the relevancy of the factor. And * (on and off) on the left of "B Consent's become effective" shows that the relevancy of the legal requirement factor is being judged at present. Answering Y to "A Offer's become effective," the child flowchart (grandchild of Figure 9) "AAAA Offer's become effective" was executed (Figure 11). In Figure 11, Y or N to the left of frames shows the conclusion of the relevancy of each factor and * ( ) indicated that an affirmative conclusion has been reached, namely the creation of effect of the offer as the creation of the legal effect of the legal norm in question. By pushing the RETURN key the page goes back to the main logic flowchart "AAA Satisfaction of formation requirement of contract" which is the parent of this logic flowchart. As a result, Y has appeared to the left of the frame of "A Offer's become effective," * begins to blink on and off on the left of "B Consent's become effective." In Figure 10, * on the left of the second legal requirement "B: Con-

sent's become effective," shows reasoning is taking place here, that is, the relevancy of legal requirement factor is being analyzed. Here the reasoning can move to the child flowchart of the legal requirement factor. So the logic flowchart "AAAB Creation of effect in the consent" (Figure 12)[20] appears on the display. On the page, * blinks on and off to the left of _____ . It asks the user whether he will execute this logic flowchart. The reasoning of the system, composed of expansive processes of logic flowcharts of legal norm sentences, is executed in the above mentioned way.

Each sub-system of *creation of legal relation, dissolution of legal relation* and *modification of legal relation* stores and describes the conclusion of reasoning as seen on the last page (see Figure 7–4, 7, and 10). They are totally described in the last procedure (see Figure 7–13). At the present time, the conclusion of the system of "Creation of legal relation" has been completed (see Figure 7–4).

The "Creation of legal felation" system has as a reasoning consequences whether or not the legal relation is created on the basis of the fact as well as the legal requirements in question. When it is created, the consequence of the reasoning is described for example as in Figure 13.

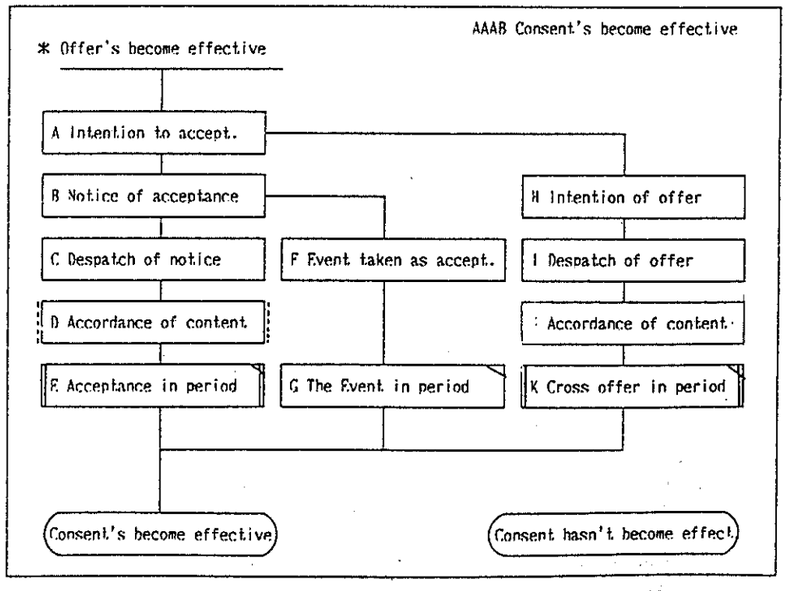

Figure 12. Example of logic flowchart of legal norm sentence (child 2)


```
                                                    Created legal relation

The legal relation has been created based on the sale concerned:

1. A has duty against B to transfer a property right of the diamond to B,
   on 5.9.1984-5.9.1984, at Japan Martial Arts Hall,
 and
   B has right against A to claim to transfer a property right of the diamond
   to B on 5.9.1984-5.9.1984 at Japan Martial Arts Hall.


2. B has duty against A to pay ¥1,000,000 for the purchase-price of the diamond
   to A on 6.9.1984 at Hotel Japan,
 and
   A has the right against B to claim to pay ¥1,000,000 for the purchase-price of
   the diamond to A on 6.9.1984 at Hotel Japan.




                                                    HIT RETURN FOR NEXT
```

Figure 13. Example of output of the system

7. An Estimate of the System and a Glimpse of the Future

In this chapter, I will evaluate our system which was introduced here and propose a topic for further research, suggesting simply the trend of its future development.

This research is divided broadly into two aspects, namely the analysis of the logical structure of legal norm sentences and an application of computers in the judicial process. In the first instance, this research has analyzed the general logical structure of legal norm sentences and tried consistently to analyze and reconstruct the system of civil law – but it was limited – by means of mathematical logic. In this point, the approach of this research might well show a new theoretical systematization to civil law, different from the traditional, (historical or comparative) method of study of civil law.[21] As for the

20 In the Figure 12, "G The event in period" and "K Cross offer in period" were set as legal requirement factor from the viewpoint that the period for acceptance specified by offer (The Civil Code of Japan, Art. 521II) is relevant also to 'the event which can be taken as a declaration of Intention to accept' (Art. 526II) and to the cross offer. In this way, if we try to analyze logically and systematize law for applying computer, we can find the issues that we would usually overlook otherwise.

21 Cf. *Arai*, M., Estimation of the system – from the point of view of study of civil law, supra (*) Research Report, p. 154.

second aspect, it can be said that this research has opened up the possibility of applying computers to the reasoning of the justification in judicial process, although there are still some difficulties, namely a too small CPU, from the point of view of practical use. Let me however stress that this research was able to describe legal norm sentences and the logical connection on the CRT display by way of a logic flowchart. With this visualization of the structure of legal rules, the user can execute legal reasoning, understanding how the related legal system is applied in a certain case, what articles of legal rules or legal requirement factor are relevant, and their mutual relations. In this respect, the principle of this system is useful especially for legal education and in giving legal advice.

Judging from the characteristics of the fifth generation computer, a computer is developing into artificial intelligence. The practical use of developed artifical intelligence leads to possibility of a system in which the user speaks to a computer about a case in natural language, and the computer analyzes the meaning of the statement to decide what legal problem lies in the case and what legal rules are relevant to the case. Furthermore, the computer asks the user for the necessary data and the user answers its questions. By repeating this procedure the consequence of law application to the case can be automatically reasoned. The laboratory system of this research can give a basis for such system, for it systematically involves the reasoning process of change of legal relation and logical mutual relations of legal norm sentences. For the development of a legal reasoning system with an artificial intelligence capability it is necessary that the amount of data of logically analyzed legal norm sentences be enlarged, that all the legal norm sentences be analyzed by predicate logic to construct a knowledge base of legal norm sentences as rule sentences of the type used in an artificial intelligence language (e.g., PROLOG) on a large-capacity high-speed AI-machine, and finally that software suitable for a whole reasoning system (i.e., reasoning engine) be completed. This is the very subject that we are researching now.[22]

Finally, I should like to stress the following point. If such a legal reasoning system as this has been constructed in the various fields of law, it can be useful not only in legal education and practice but also to the objectification of thought of law and the judicial process, which is understandable to specialists, but which remains a black box to laymen. The objectification makes it possible for common people to know, understand and criticize the thought of law and judicial process, which leads to the democratization of law.

22 In order to develop a legal reasoning system, a study meeting has been held once a month since November 1984. The study group has developed now to "LEGAL EXPERT-SYSTEM ASSOCIATION (LESA)" which has been organized with professor Yoshino, the author, as a representative. It is composed of researchers of various fields such as legal philosophy, civil law, law of procedure, logic, linguistics, information knowledge science. We are now developing an automatic legal reasoning system by means of PROLOG on the bases of intensive predicate logical analyses of legal norm sentences.

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