

14 April 2000).

- 62 CBD Decision VI/24 A, 2002. Protection of Biological and Genetic Resources, Proposal by the Delegation of Colombia, SCP/3/10, 8 September 1999.
- 63 Guidance for promoting synergy among activities addressing biological diversity, desertification, land degradation and climate change (UNEP/CBD/SBSTTA/11/18).
- 64 Para. 8, Biodiversity and climate change: guidance to promote synergy among activities for biodiversity conservation, mitigating or adapting to climate change and combating land degradation, Decision VIII/30.
- 65 A new definition of wise use of wetland is "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". See Resolution IX.1 A, Annex A: Conceptual Framework for the wise use of wetlands and the maintenance of their ecological character.
- An old definition of wise use of wetland was "their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem", and sustainable utilization was defined as "human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations". See Recommendation 3.3: Wise use of wetlands.

Logical Structure of Change of Legal Relations and Its' Representation in Legal Knowledge Base System in the Use of Legal Education

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Abstract

It is important for lawyers to identify the rights and duties that come into existence as a result of the application of law to a concrete case-problem. It is important for legal education to develop a students' capability to reason this state of affairs of legal relation under certain legal and factual situations. A legal knowledge base system, which logically infers the legal state of affairs as a conclusion from law together with the facts of a case and which clearly shows the reasoning process, is to be a useful tool for legal practice and education. As the legal state of affairs changes according to the time-progress of an event, it is needed to clarify logical structure of changes of legal relation and constitute a logical model to prove changes among legal relationships over time in order that such a legal knowledge base system is constructed. This study presents a logical model to represent the change of legal relation based on the concepts of legal sentence as well as their validity and applies it to a contract law, i.e., the United Nations Convention on Contracts for the International Sale of Goods (CISG) to construct its deductive knowledge base. As a visual representation method to represent the change of legal state of affairs, we have introduced the belt figure of the validity of legal sentences in our legal knowledge base system in order that one can well understand the change in rights and duties relations.

Keywords:

Legal Knowledge Base System, Artificial Intelligence of Law, legal knowledge, legal education, legal reasoning, visual representation, logical model of law, Logical Jurisprudence, legal relation, right and duty relation, contract, CISG

Introduction

A legal knowledge base system (LKBS) is a computer system which contains legal knowledge and infers the possible legal result of the application of law to certain cases and explains the reasoning process as well as the legal knowledge that is applied.

It is important for a lawyer to be able to explain the legal state of affairs that is connected with the case with which he deals. To identify what kind of legal state of affairs exists is to reason what kinds of rights and duties exist. For legal education, it is important to educate students so that they have the capability of performing such reasoning. A legal knowledge base system, which infers the legal state of affairs as a conclusion from law together with the facts of a case, and which clearly shows the reasoning process, will, therefore, be a useful tool for legal education.

In order to create a legal knowledge base system, it is necessary to clarify the structure of the law as a deductive system from which a legal judgment can be justified as the conclusion of the relevant legal rules and facts. As the legal state of affairs changes according to the progress of an event, a clarified logical model of law is necessary to enable us to detect changes among legal relationships over time, from the beginning to the end of a case. This study presents such a model based on "Logical Jurisprudence," in which the relationship between legal sentences and the legal meta sentences regulating the validity of legal sentences play a definitive role. The model is applied to a contract law, i.e., the United Nations Convention on Contracts for the International Sale of Goods (CISG). Thus, the deductive structure of the contract law is clarified so that the appropriate answers to questions about the legal state of affairs at any time are logically deduced as results of the application of CISG provisions to concrete case-problems. On this basis, we have constructed a legal knowledge base system of the CISG, LES-6 and LES-7.¹

In this respect, a visual representation will be useful in representing

the change in rights and duties relations that students will need to understand as regards the movement of the legal state of affairs. Therefore, I have introduced the belt figure of the validity of legal sentences which describe rights and duties, in aid of our legal knowledge base system.

In this paper, we will demonstrate (1) the basic concepts in Logical Jurisprudence, (2) the representation of changes of legal relations, (3) a case-problem and solution related to the CISG as an example for discussion, (4) the legal meta sentences which decide the validity of legal sentences, (5) the legal knowledge base systems developed by us and (6) the applicability of the legal knowledge base system to legal education.

1. Basic Concepts in Logical Jurisprudence

Logical Jurisprudence is our logical theory of law: Logical Jurisprudence tries to define the world of legal discourse in terms of the smallest unit of primitives. It starts from three primitives: "sentence," the "validity" of a sentence, and the "inference rule." Logical Jurisprudence attempts to explain the law by using these three notions as much as possible.

Logical Jurisprudence does not support the existence of "legal norms as a meaning," which has traditionally been admitted or presupposed in legal studies and legal practice. Logical Jurisprudence starts from the notion of "**legal sentences**." Sentences exist as a form of written or spoken signs and they are supposedly perceptible, and therefore, communicable. In my opinion, the meaning of legal norms belongs to the world of images. It is what one imagines when legal sentences are thought of. To communicate such images to other persons, they must be put into sentences that are comprehensible to others. Logical Jurisprudence considers sentences in the field of law to be the direct object of legal recognition.²

The second basic concept in Logical Jurisprudence is the "**validity**" of a legal sentence. The validity of a legal sentence is viewed by Logical Jurisprudence as a "truth in the logical sense." That a legal sentence is valid means that it is true in the world of legal discourse, i.e., legally true.

Logical Jurisprudence represents this legal truth by means of a predicate (e.g., "is_valid (sentence 1, goal 1, time 1)," which could be read as follows: "a sentence 1 is valid for goal 1 at time 1"). The representation of the concept of validity by a predicate is a characteristic of Logical Jurisprudence that corresponds to the natural linguistic representation of knowledge in the legal world.

The third basic concept in Logical Jurisprudence is the "inference rule." Logical reasoning is based on inference. The main rule of inference is in *Modus Ponens*, which is represented in the following schema, where A and B express propositions:

$$(A \Rightarrow B) \& A \Rightarrow B$$

This formula is to be read: 'if A then B' is true and A is true, then it follows that B is true. *Modus Ponens* is the basic reasoning schema of legal justification as will be discussed later.

In Logical Jurisprudence, legal reasoning is the process of the development of legal sentences. In other words, legal sentences are developed through the process of legal reasoning.

Logical Jurisprudence divides legal reasoning into the reasoning of justification and the reasoning of creation. The *reasoning of legal justification* is reasoning through which a judgment is justified from already-justified legal knowledge. Logical deduction is the type of reasoning of legal justification. The logical structure of this reasoning is that of *Modus Ponens*. Judgment may not be deduced from statutes and facts alone, but it may be deduced from the whole body of legal knowledge, including statutes, facts, and additional legal sentences to the former, as is implicit in legal common sense, or, as a result of the reasoning of legal creation. Logical Jurisprudence makes this implicit or created knowledge clear and identifies it so as to make it explicit. The following are additional legal sentences: legal principles that unify statutory legal sentences; common sense about law and legal terms, especially hierarchical relations between legal concepts; and the interpretation of statutes that are produced by the

reasoning of legal creation. Logical Jurisprudence analyzes legal knowledge in detail, and recognizes and demonstrates the implicit knowledge of legal experts and legal sentences created by the reasoning of legal creation, such that the reasoning of legal justification is formed as logical deduction.

The *reasoning of legal creation* is reasoning through which judgments themselves or additional legal sentences are either discovered or created. This reasoning is related to logical deduction because legal sentences are created so that a legal judgment is to be legally justified, i.e., to be shown as a conclusion of logical deduction from the whole legal premises including these additional sentences. The reasoning of legal creation is performed through falsification reasoning, which has the logical structure of *Modus Tollens*:

$$(A \Rightarrow B) \& \neg B \Rightarrow \neg A$$

This formula is read as follows. 'If one sets hypothesis A (together with already accepted theorems), then B follows' and it is proven that B is not true. Thus, it follows that the hypothesis A also is not true. (The legal hypothesis cannot be proven as just but can only be falsified as unjust.)

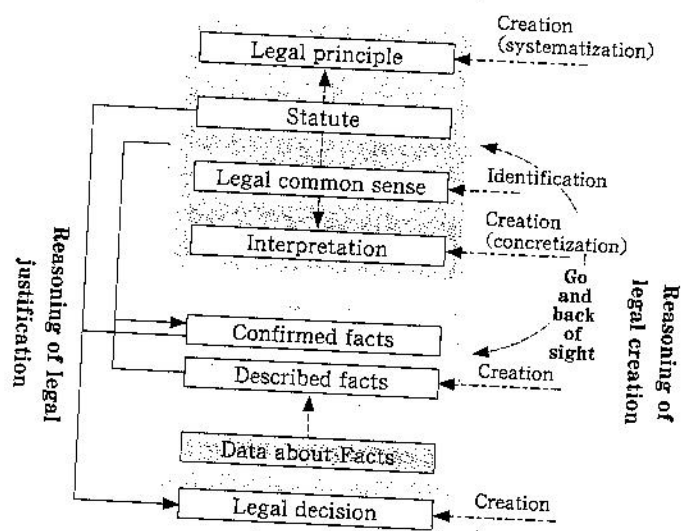
The reasoning of legal creation, however, requires something more than deduction. Reasoning to get a sentence of hypothetical fact is abduction and reasoning to get a sentence of hypothetical rule constitutes induction.

Logical Jurisprudence analyzes the legal reasoning process in two ways: (1) concretization and (2) systematization. This is also the case for the legal reasoning of creation. Through the interpretation of statute texts, terms of statutes are concretized, namely putted into concrete terms, which are more close to fact sentences, creating legal sentences which describe inclusion relations of the latter terms in the former terms. In systematization, sentences of legal principles are created which will enable us to bring mere collections of legal sentences into a deductive system.

The study of reasoning in legal creation is important to the theory of law, both as regards concretization³ and systematization⁴. Few engineers, however, study the systematization of legal knowledge itself, i.e., the process of showing laws as a deductive system. This is because engineers assume that a theory of science is deductive, so they are not interested in finding the deductive structure of law. Moreover, legal knowledge is too specialized and complicated for engineers to identify deductive relationship of legal knowledge. To construct a legal knowledge base system, however, the deductive structure of law must be clarified to develop a deductive knowledge base. Clarifying the deductive system of law and systematizing legal knowledge have long been desired in legal studies⁵. We focus on the process of systematizing the law of contracts toward a logically deductive knowledge base⁶ of the CISG, leaving the reasoning of legal creation for another time.⁷ What has been explained about the structure of legal reasoning can be shown visually in **Figure 1**.

I would like to clarify the concept of legal sentences more precisely.

Figure 1: Legal Reasoning as Developing Process of Legal Sentences



Sentences in the legal field, referred to here as *legal sentences*, are starting points, as above explained. We introduce the basic kinds of sentences, according to which all legal sentences are classified, so that laws can be systematized as logical deduction.

Legal sentences consist of two types: legal rule sentences and legal fact sentences. It is important to distinguish between the two legal sentences. *Legal rule sentences* have the following syntactic form: " $\forall X \{a(X) \leftarrow b(X)\}$." This formula is read as: "For all X , X is a , if X is b ." In legal sentences, the consequence of the sentence, which is the portion on the left in the formula, $a(X)$, is called a "legal consequence," and the antecedent portion on the right, $b(X)$, is called a "legal requirement." On the other hand, *legal fact sentences* have the following syntactic form: " $b(x1)$," which is read as: " $x1$ is b ." Note that the difference between legal rule sentences and legal fact sentences is purely syntactic in Logical Jurisprudence, as mentioned above.

Second, legal sentences are to be further classified in terms of elementary legal sentences or complex legal sentences. An *elementary legal sentence* is the smallest unit of legal sentences. Statutes or contracts are composed of elementary legal sentences, e.g., "one must drive a car under 85 miles per an hour on a highway" or "A may require B to pay the price of \$10,000." A *complex legal sentence* is a group of legal sentences, such as "the United Nations Convention on Contracts for the International Sale of Goods," or "a contract for sale of a farming machine between A and B on October 8th 2005." A code, and parts or sections of an article of a statute are complex legal sentences. In most cases, the fact that a certain legal sentence belongs to a complex legal sentence is represented by the placement of the sentences and the space where it is printed. The relationship is represented in Logical Jurisprudence by a sentence describing the unified relationship of grouped sentences. The concept of a complex legal sentence enables us to treat the validity of all legal sentences at once. Namely, if one has described the validity of a complex legal sentence, then all legal sentences that belong to it are also valid. The advantage of the

complex legal sentence is that it contributes to economical description of validity of legal sentences.

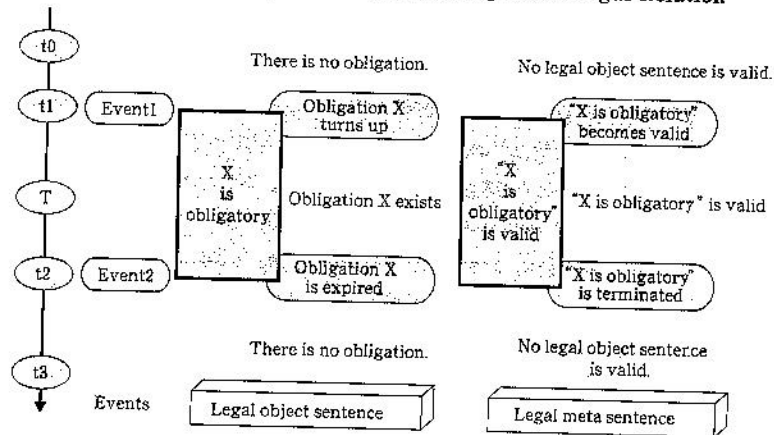
It is also important for the deductive systematization of legal knowledge to distinguish between legal object sentences and legal meta sentences. A *legal object sentence* describes the object itself. In the legal domain, the object is an "obligation." Legal object sentences prescribe the obligations of a person. The sentence "one must drive a car under 65 miles per an hour on a highway" or "B must pay A the price of \$10,000" is a legal object sentence. A *legal meta sentence* describes about legal sentences. More precisely, it describes the validity of a legal sentence. Some legal meta sentences describe the validity of other legal meta sentences. An example of a legal meta sentence is: "A law is enforced 20 days after the day of its promulgation" [article 2 of the General Act governing the application of laws in Japan]. Another example is the following: "(1) This Convention applies to contracts of the sale of goods between parties whose places of business are in different states: (a) when states are contracting states; or ..." (article 1 of the CISG).

2. Representation of Changes of Legal Relations

Law ultimately prescribes the obligations of persons. In other words, people's conduct is ultimately regulated by obligations imposed by law. What legal obligations exist depend upon the legal sentences that describe the obligations, or more precisely, on the validity of the sentences that describe the obligations. The validity of legal object sentences is prescribed by legal meta sentences. In Logical Jurisprudence, the existence of A's obligation to Z means that a legal sentence which describes A's obligation, such as "A has an obligation to do Z" or "It is obligatory for A to do Z," is legally valid. The relation of the existence of an obligation and the validity of a legal object sentence describing the obligation are represented visually in Figure 2.

The same is the case for the existence of the right. What legal rights

Figure 2: Visual Representation of Changes of a Legal Relation



exist means that legal sentences describing the right are legally valid. The validity of legal sentences that describe the rights is prescribed by legal meta sentences. Fig. 2 applies also to the concept of rights, if the word "obligation" is replaced with "right" and "obligatory" with "entitled." Using this belt figure which represents the validity of legal sentences that describe a duty or a right, we can visually represent the existence of rights and duties relations as well as the change in legal relations.

The validity of legal meta sentences that prescribe legal sentences is prescribed by other legal meta sentences. A legal meta sentence that prescribes the validity of a legal meta sentence is called a *higher or upper level legal meta sentence*. The validity of each legal meta sentence is prescribed by a higher level of legal meta sentence. The highest, final level of legal meta sentence is called a "basic" or "fundamental" legal sentence. The validity of this final, highest legal meta sentence is described by a fact sentence⁵.

It should be noted that legal sentences describing rights are not legal object sentences, which should describe obligations. They do not belong to an object level of legal language but to a meta level. Logical Jurisprudence considers the sentences which describe rights as a kind of legal

meta sentences, which make it possible to set forth a new legal object sentence. This will be discussed again later [4.2.2].

3. Case-Problem and Solution

It is an effective way for legal education to develop students' reasoning capability, to give them case-problems which they should solve and explain.

This section describes an example of a case-problem relevant to the CISG. It describes the circumstances of a particular example of that problem, asks questions about that example and introduces legal solutions to those questions in order to clarify the deductive knowledge structure of contract law by which solutions may be deduced.

[Case 8f]

- (1) On April 1st, A (Anzai), a farming machine maker in New York sent a letter to a branch office of a Japanese trading company B (Bernard) in Hamburg. The letter indicated that A was to sell B a set of farming machines comprised of a tractor and a rake; the price of the tractor is \$50,000; A was to deliver the machine to B by May 10th; B was to pay the price to A by May 20th and the machine was to be transported by an American freight vessel.
- (2) On April 8th, the letter reached B's letter box at the branch office in Hamburg.
- (3) On April 9th, B made a telephone call to A, saying, "I accept your offer. However, I want the machinery transported by Japanese container ship."
- (4) On May 1st, A finally handed the farming machine over to a Japanese container ship at a port in New York.
- (5) On May 20th, B paid \$58,000 to A. (The market price of the rake was \$8,000.)
- (6) On May 31st, the machine was delivered to the branch office in Ham-

burg.

- (7) On June 5th, B examined the machine.
- (8) On August 10th, the machine proved to be operating out of order because of a faulty connection gear.
- (9) B immediately notified A specifying the nature of the problem.
- (10) On September 1st, B asked A to repair the problem within one month. A did not repair it until October 1st.
- (11) On October 10th, B declared the contract avoided.
- (12) On December 10th, A recovered damages and B restituted the machine delivered by A.
- (13) On December 20th, A restitutes the price paid by B.

[Question]

The following questions are set as examples.

At each of the points in time below, what are legal relations that exist between A and B?

- 1: April 5th
- 2: April 15th
- 3: May 5th
- 4: August 15th
- 5: September 15th
- 6: October 5th
- 7: November 15th
- 8: December 15th
- 9: December 25th

The following CISG articles apply:

Article 15

- (1) An offer becomes effective when it reaches the offeree.
- (2) An offer, even if it is irrevocable, may be withdrawn if the withdrawal reaches the offeree before or at the same time as the offer.

Article 16

- (1) Until a contract is concluded an offer may be revoked if the revoca-

tion reaches the offeree before he has dispatched an acceptance.

Article 18

(2) An acceptance of an offer becomes effective at the moment the indication of assent reaches the offeror. (first sentence)

Article 23

A contract is concluded at the moment when an acceptance of an offer becomes effective in accordance with the provisions of this Convention.

Article 31

If the seller is not bound to deliver the goods at any other particular place, his obligation to deliver consists:

(a) if the contract of sale involves carriage of the goods — in handing the goods over to the first carrier for transmission to the buyer;

Article 38

(1) The buyer must examine the goods, or cause them to be examined, within as short a period as is practicable in the circumstances.

Article 39

(1) The buyer loses the right to rely on a lack of conformity in the goods if he does not give notice to the seller specifying the nature of the lack of conformity within a reasonable time after he has discovered it or ought to have discovered it.

Article 45

(1) If the seller fails to perform any of his obligations under the contract or this Convention, the buyer may:

(a) exercise the rights provided in articles 46 to 52;

(b) claim damages as provided in articles 74 to 77.

(2) The buyer is not deprived of any right he may have to claim damages by exercising his right to other remedies.

Article 46

(1) The buyer may require the performance by the seller of his obligations unless the buyer has resorted to a remedy which is inconsistent with this requirement.

(2) If the goods do not conform with the contract, the buyer may require

delivery of substitute goods only if the lack of conformity constitutes a fundamental breach of contract and a request for substitute goods is made either in conjunction with notice given under article 39 or within a reasonable time thereafter.

(3) If the goods do not conform with the contract, the buyer may require the seller to remedy the lack of conformity by repair, unless this is unreasonable having regard to all the circumstances. A request for repair must be made either in conjunction with notice given under article 39 or within a reasonable time thereafter.

Article 47

(1) The buyer may fix an additional period of time of reasonable length for performance by the seller of his obligations.

Article 49

(1) The buyer may declare the contract avoided:

(a) if the failure by the seller to perform any of his obligations under the contract or this Convention amounts to a fundamental breach of contract; or

(b) in case of non-delivery, if the seller does not deliver the goods within the additional period of time fixed by the buyer in accordance with paragraph (1) of article 47 or declares that he will not deliver within the period so fixed.

Article 55

Where a contract has been validly concluded but does not expressly or implicitly fix or make provision for determining the price, the parties are considered, in the absence of any indication to the contrary, to have impliedly made reference to the price generally charged at the time of the conclusion of the contract for such goods sold under comparable circumstances in the trade concerned.

[Solution]

The solution of the above case is as follows.

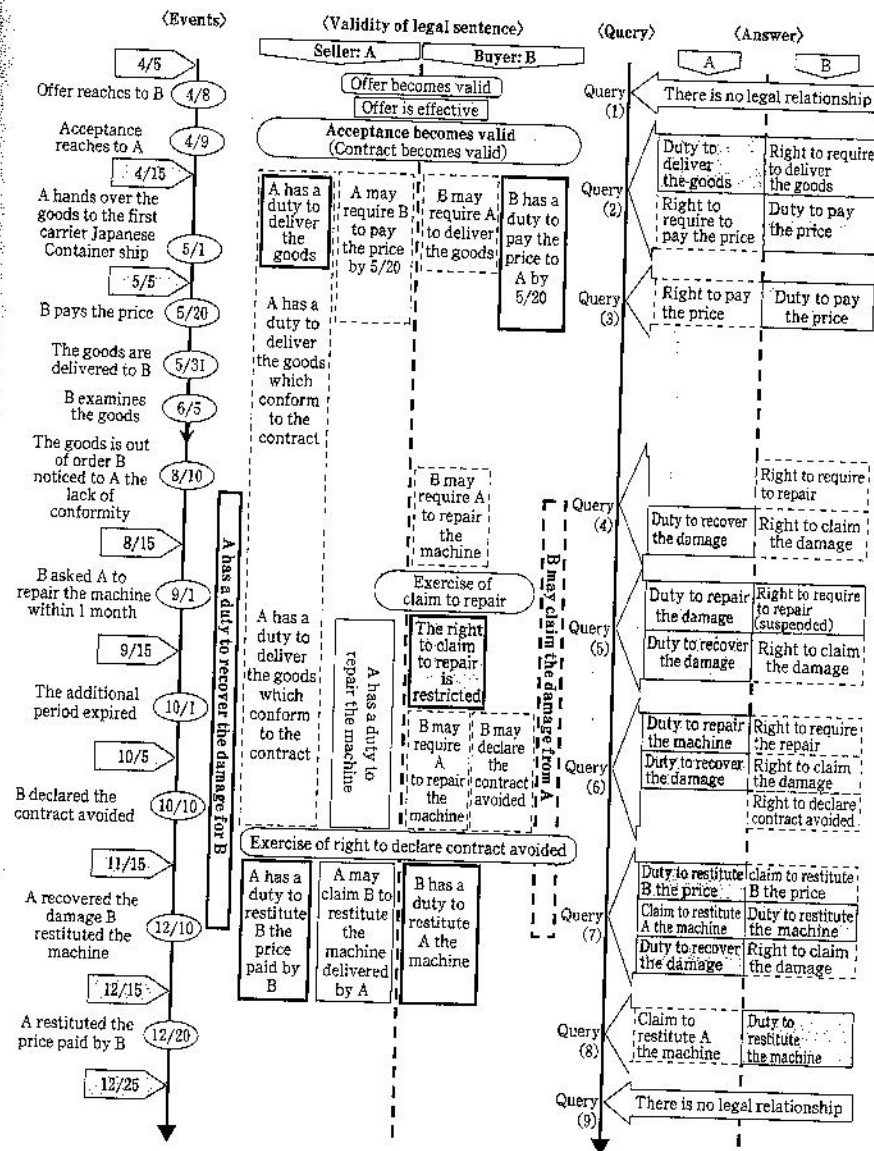
1) On April 5th, there is no longer any legal relation between the seller A

- and the buyer B.
- 2) On April 15th, A has a duty to deliver the farming machine to B by May 10th and B has a duty to pay \$58,000 to A by May 20th, while B has the right to require A to deliver the goods to B by May 10th and A also has the right to require B to pay the price to A by May 20th.
 - 3) On May 5th, B has a duty to pay \$58,000 to A by May 20th, while A has the right to require B to pay the price to A by May 20th.
 - 4) On August 15th, A has the duty to recover damages, while B has the right to claim damages against A, and B has the right to require A to repair the machine.
 - 5) On September 15th, A has the duty to recover damages and a duty to repair the machine, while B has the right to claim the damages against A, and B has the right to require A to repair the machine, which is suspended to exercise.
 - 6) On October 5th, A has the duty to recover damages and a duty to repair the machine, while B has the right to claim the damages against A, and B has the right to require A to repair the machine, whereas B has the right to declare the contract avoided.
 - 7) On November 15th, A has the duty to recover damages and the duty to restate the price B has paid, and B has the duty to restate the machine delivered by A, while B has the right to claim damages against A and the right to require A to restate the price, and A has the right to require B to restate the machine.
 - 8) On December 15th, A has the duty to restate the price paid by B, while B has the right to require A to restate the price.
 - 9) On December 25th, there is no legal relation between A and B on the contract.

The changes of legal relation according to the time progress in case 8f are shown in Figure 3.

The above solutions correspond to obligation and right. In this chart, the existence of legal relations is indicated by the belt of the validity of legal sentences which describe obligations and rights in the figure.

Figure 3: The Changes of Legal Relation



4. Legal Meta Rule Sentences to Decide the Validity of Legal Sentences

In Logical Jurisprudence, the existence of an obligation means that a legal object sentence describing the obligation is valid, as mentioned above. The existence of A's obligation to deliver a farming machine to B means that "A has an obligation to deliver a farming machine to B" or "It is obligatory for A to deliver a farming machine to B" is valid. If the party has an obligation to deliver a farming machine to B based on a contract, it is so because the sentences in the contract describing the obligation (that is, legal object sentences) is valid as proved. The contract law is a set of legal meta rule sentences that regulate the validity of the legal object sentences of the contract. Below, we show what kind of legal meta rule sentences work to prove the validity of the legal object sentences related to the contract and how they do so.

4.1. Legal Meta Rule Sentences Deciding that Legal Sentences Are Valid

The following fundamental legal meta rule sentence is valid for deciding that legal sentences are valid⁹:

[O] "A legal sentence *S* is valid for a goal *G* at the time *T* if and only if *S* becomes valid for *G* at time *T*₁ before *T* and *S* is not terminated for *G* after *T*₁ and before *T*."

This legal rule sentence cannot be found in a statutory text such as the CISG or other regulations. This is a fundamental legal meta rule sentence implicitly taken for granted by the CISG and all other regulations. Without this rule, no statutory legal sentence works when it comes to application. This rule is the most fundamental among legal meta rules enabling us to put a mere collection of legal sentences into a legal system. This rule applies to every case where the validity of legal sentences is considered.

In deciding for example, whether legal sentence "A has a duty to deliver the machine to B on April 15th" is valid, we apply this rule and examine its two specified requirements: "A has a duty to deliver the machine to B' becomes valid before April 15th" and "A has a duty to deliver the machine to B' is not terminated until April 15th." If both requirements are satisfied, then the legal object sentence is valid, on April 15th. Consequently, A's duty to deliver the machine exists in the prevailing usage of legal language. If not, it is not valid, and consequently the duty does not exist.

How are legal sentences to be systematized under this fundamental legal meta rule sentence? All other legal meta rule sentences are systematized as sub-rules of this sentence, as rules to decide whether the two different requirements of this fundamental meta rule sentence, i.e., "the legal sentence becomes valid" and "the legal sentence is not terminated," are satisfied¹⁰.

Now, we shall clarify the structure of legal knowledge deciding these two factors, i.e., "the legal sentence becomes valid" and "the legal sentence is not terminated" focusing on the validity of legal object sentences in order to make the logical structure of legal knowledge regulating changes of legal obligation clear. Here, note the following: "the legal sentence is not terminated" means "it is not the case that the legal sentence is terminated." In the real legal world, there is no rule that decides directly "a legal sentence is not terminated," but many legal rule sentences exist which decide "a legal sentence is terminated." The legal rules sentences that decide "a legal sentence is terminated" play their role through 'Negation as a Failure'¹¹ for the second requirement of the fundamental meta rule 'O'.

4.2. Legal Rules Sentences Deciding Accrual of Obligation

Legal obligations accrue because legal object sentences become valid as mentioned above.

4.2.1. Accrual of Validity of Elementary Legal Sentences with Accrual of Contract Validity

The accrual of validity of a complex legal sentence follows the accrual of validity of elementary legal sentences belonging to it. The following legal meta rule sentence is presupposed:

[01] An elementary sentence becomes valid at the time T if it is an elementary sentence of complex sentence at the time T and if the complex sentence becomes valid at the time T.

Consider, for example, the change in the legal relation on April 9th in Fig. 3. As the contract as a complex legal sentence has become valid, the following two obligation sentences (legal object sentences) as elementary legal sentences of the contract, become valid: "A has a duty to deliver the goods to B by May 10th" and "B has a duty to pay the price to A by May 20th." The main part of contract law is legal meta rule sentences regulating changes of validity of the contract itself as a complex legal sentence, i.e., the accrual and termination of its validity.

Figure 4 is one of screens of LES-7's explanation system which represents the legal rule sentence that decides the accrual of validity of contract. The first requirement of the rule in Fig. 4, "the contract by _E concerning _H" is concluded at time _L, means that the contract is concluded. The "conclusion" of the contract means that it is formed as a legal (complex) sentence named contract. Legal sentences differ from conventional sentences because legal sentences are made satisfying the requirements of legal meta rules prescribing the formation of the relevant legal sentences such as contracts, judgments, statutes, constitutions and conventions.

Part 2 of the CISG regulates in detail the conclusion of contract from articles 14 through 24.

The rule 2a (Figure 5) is related to article 23, but is not the same. The article 23 does not refer to the effectiveness of an offer directly. For article 14 to be systematized into the rule regulating contract formation, the

Figure 4: [3AA1B] A Contract Becomes Valid

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LES7 User ID: HY2
CISG14 CISG12
LOGICAL STRUCTURE of the RULE(3AA1B)
"the contract by _E concerning _H" becomes valid at time _I.
IF
(
  (
    "the contract by _E concerning _H" is concluded at time _L.
    AND
    (
      NOT(
        the contract by _E concerning _H is invalid for _O at _J
      )
      AND
      (
        the contract by _E concerning _H contain _T that is the time of commencement at time _J
        AND
        d_call(I=T)
      )
    )
  )
  OR
  (
    the contract by _E concerning _H contain the condition to become valid at time _J
    AND
    _Y is fulfilled at time _J
  )
  OR
  (
    NOT(
      the contract by _E concerning _H contain condition under _E1 for _D1 at time _J
    )
    AND
    "the contract by _E concerning _H" is concluded at time _L.
  )
)
)

```

Figure 5: [2a] Contract Is Concluded

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LES7 User ID: HY2
LOGICAL STRUCTURE of the RULE(2a)
"the contract by [C,D] concerning _I" is concluded at time _J.
IF
(
  "C_s offer of [C,D] concludes the contract by [C,D] concerning _I at time
  _J to _D the content of which is _O" becomes effective at time _W
  AND
  "_D_s acceptance" becomes effective at time _J after _W
)

```

first requirement of rule 2a must be made adding to article 23. This legal rule sentence 2a therefore is to be considered as a legal principle of contract law¹². (This rule would be valid for the case of the CISG and also for other contract laws.) Article 14 is to be systematized as a sub-rule of the

first requirement of this legal principle. Article 18 (2) is systematized as a sub-rule of the second requirement.

4.2.2. Accrual of a Legal Object Sentence by Exercising Rights

In some cases, the accrual of validity of the elementary legal sentence by itself, not as a result of the accrual of contract validity, is regulated. An obligation accrues, for example, along with exercise of the relevant right. In Fig. 3, the legal sentence "A has a duty to repair the machine for B" becomes valid because B exercised the right to require the repair of the machine on September 1st.

Logical Jurisprudence does not consider sentences describing rights as a legal object sentence as in the prevailing opinion in legal theories, but as a legal meta rule sentence, as described above. That a person has a right to require another person to do Z, for example, means, in our opinion, that the person has a power to make valid, by his indication of intention, an object sentence that the other person is obligated to do Z.

The legal meta rule sentence below must be valid.

[3aa2] "A sentence 'X has an obligation to do Z' becomes valid at time T, if a sentence 'Y has a right to require X to do Z' is valid at time T and Y exercises the right to require X to do Z at time T."

The accrual of seller A's concrete obligation to repair the machine on September 1st, for example, in Fig. 3 for the present case is deduced by the application of this rule. The proof is as follows. The second requirement of the rule "Y exercises the right to require X to do Z at time T" is satisfied by buyer B's exercise of the right to require seller A to remedy the lack of conformity by repair on September 1st. The instantiated first requirement "Buyer B has a right to require seller A to remedy the lack of conformity by repair on September 1st, is valid" is proved by applying the fundamental meta rule 0. The instantiated first condition of the latter rule "Buyer B has a right to require seller A to remedy the lack of conformity by

repair' becomes valid on August 10th" is proved by applying the following legal rule sentence representing article 46 of CISG:

[rCISG46] "The buyer has a right to require the seller to remedy the lack of conformity by repair" becomes valid, if the goods do not conform with the contract.

The requirement of the rule rCISG46 is satisfied by the fact (8) of [case 8f] on August 10th. The instantiated second requirement of the applied 0 "B has a right to repair the machine' is not terminated until September 1st" is proven because the proof of "B has a right to repair the machine' is terminated until September 1st" is failed.

The deductive system of legal knowledge to deduce an accrual of the validity of a legal object sentence by exercising a right of claim is explicated in an example of the claim to repair the goods delivered. Legal meta rule sentence 3aa2 applies to many other cases such as accruals of the seller's duty to perform his obligations (article 46(1)), to deliver substitute goods (46(2)) and so on.

Many statutory legal rule sentences regulate the accrual of validity of legal object sentences directly. In such a case, one needs not to apply rule 3aa2.

4.3. Legal Rule Sentences Deciding the Termination of Obligations

The termination of obligations means that the validity of legal object sentences describing obligations is terminated. There are two ways to terminate the validity of elementary legal object sentences: the termination of their validity along with the termination of the complex legal sentence to which the elementary sentences belong and the termination of their validity by themselves.

4.3.1. Termination of Elementary Legal Sentence through Contract Termination

The validity of elementary legal sentences is terminated if the com-

plex legal sentence to which they belong is terminated. That is also the case in the contract. The following meta rule sentence is to be valid:

[02] *The validity of elementary sentences of a contract is terminated if the validity of the contract as a complex legal sentence is terminated.*

Complex legal sentences lose their validity on the day when a fixed term is expired, when the termination condition is met or when contract avoidance becomes effective. Regulations concerned with these factors can be integrated as a legal rule sentence, which makes concrete the second requirement of the fundamental legal meta rule sentence θ as its sub-rule sentence.

In Fig. 3, two legal object sentences "A has a duty to deliver the goods which conform to the contract" and "A has a duty to repair the machine" are terminated on October 10th, because the validity of the contract as a complex legal sentence was terminated owing to B's exercise of the right to declare the contract avoided when he has the right, i.e., "B has the right to declare the contract avoided" is valid. The right to declare the contract avoided resulted from the fact that the seller had not fulfilled an obligation to repair the machine within the additional period of time (one month) fixed by the buyer¹⁸.

4.3.2. Termination of Validity of Elementary Legal Object Sentences with Fulfillment of Its Obligation

In some cases, the validity of one article of the contract is terminated independently of the validity of the whole contract. The following legal meta rule sentence is valid:

[mr4b] *"The validity of elementary legal object sentences is terminated when the obligation is fulfilled."*

For example, because of the delivery of the machine by A on May 1st,

the validity of the legal object sentence "A has a duty to deliver the machine to B" is terminated May 1st, and because of payment by B on May 20th, the validity of legal sentence "B has a duty to pay the price by May 20th" is terminated May 20th. These terminations of obligations are deduced by applying the above legal meta rule sentence *mr4b*.

5. The Legal Knowledge Base Systems

The result of the clarification of the logical structure of the contract law system is applicable to construct a legal knowledge base on contract law. We have tried this application in the field of the CISG and made a CISG knowledge base of which our legal knowledge base system is composed. Here, I would like to describe shortly about the legal knowledge base systems LES-6 and LES-7 developed by us.

5.1. Representation of Legal Knowledge in Terms of the Logical Flow Chart

The logical structure of the contract law system and the CISG was represented at first in terms of the logical flow chart. This approach is useful for knowledge engineers to analyze the logical structure of law, represent it and communicate with other people especially with lawyers. Lawyers or law students can also use this method for themselves, what is an advantage of the use of logical flow charts. This visual approach is also effective for students to analyze and understand the logical structure of law. The logical flow charts written are then converted to a kind of predicate formula CPF, which is to be explained just in the next section, for the knowledge base.

5.2. Legal Knowledge Representation in Terms of CPF

Legal knowledge which is composed of fundamental meta rules, legal principles, the CISG articles and its interpretations, is represented in the legal knowledge base in terms of CPF (Compound Predicate Formula) in

the knowledge base. CPF is an extended form of the first order predicate logical formula¹⁴.

It entails the extension in the following characteristics:

- (1) It introduces identifiers of predicates to designate the entity which a term through the relevant predicate represents.
- (2) It contains Case List which is a list of pairs and each pair represents case role and filler.
- (3) It has compound structure in that any filler may be a compound predicate term.

CPF has so strong a knowledge representation capability that it can represent complex relations of legal state of affairs. Here, as examples of legal rules represented in terms of CPF in the CISG knowledge base, the fundamental meta rule sentence (0) and the legal rule sentence (2a) which corresponds in contract law principle of Fig. 5 is shown below.

```

sen('0',[
is_valid(_,[
    abj:sen(SEN,[cnt:[S]]),
    goa:G,
    tim:T])
<-
become_valid(_,[
    abj:sen(SEN,[cnt:[S]]),
    goa:G,
    time_before(T1,[tto:T]))
&
not(
is_terminated 2(_,[
    abj:sen(SEN,[cnt:[S]]),
    goa:G,
    tim:T2])
&

```

```

time_after(T2,[tfr:T1]) & time_before(T2,[tto:T])
)
]).

```

```

sen('2a',[
% A contract is concluded
is_concluded(IS_CONCLUDED_ID,[
    nam:IS_CONCLUDED,
    agt:[OFFEROR,OFFEREE],
    obj:contract(CONTRACT_ID,[
        nam:CONTRACT,
        agt:[OFFEROR,OFFEREE],
        cnt:CNT_CONTRACT,
        imp:IMP_OFFER,
        obj:OBJ_CONTRACT])),
    tim:T])
<-
% An offer becomes effective at the time T1.
become_effective(BECOME_EFFECTIVE_ID,[
    nam:BECOME_EFFECTIVE,
    abj:offer(OFFER_ID,[
        nam:OFFER,
        agt:OFFEROR,
        cnt:CNT_CONTRACT,
        goa:OFFEREE,
        imp:IMP_OFFER,
        obj:conclude(CONCLUDE_ID,[
            nam:B,
            agt:[OFFEROR,OFFEREE],
            obj:contract(_,[
                nam:CONTRACT,
                agt:[OFFEROR,OFFEREE],

```

```

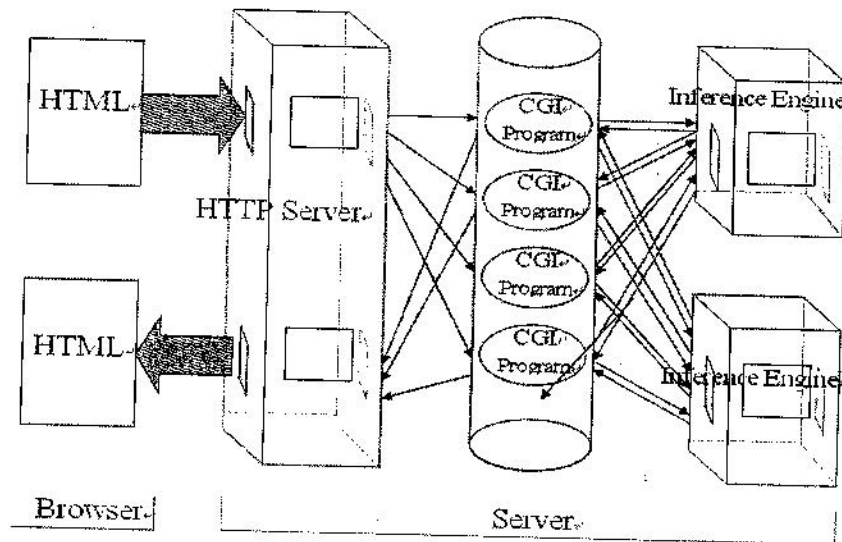
        cnt:CNT_CONTRACT,
        imp:IMP_OFFER,
        obj:OBJ_CONTRACT)),
        tim: _]),
        src:SRC_OFFER,
        tim:TIM_OFFER]],
        tim:T1))
    &
    % The acceptance of an offer becomes effective at the time T after the time T1.
    become_effective(BECOME_EFFECTIVE_ID2,[
        nam:BECOME_EFFECTIVE_2,
        abj:acceptance(ACCEPTANCE_ID,[
            nam:ACCEPTANCE,
            agt:OFFEREE,
            cnt:CNT_ACCEPTANCE,
            goa:OFFEROR,
            imp:IMP_ACCEPTANCE,
            obj:OFFER_ID,
            src:SRC_ACCEPTANCE,
            tim:TIM_ACCEPTANCE]],
            tim:time_after(T,[tfr:T1]))
        ])].
    
```

5.3. Legal Knowledge Base Systems on CISG

We have developed a legal knowledge base system LES-6 and LES-7 on CISG. Each system is constructed to allow a user to comprehend the results of the application of the law to concrete cases and their reasoning through WWW browser via internet. Any user can use the system as far as his computer has a browser and is connected to a LAN or internet.

The LES-6 and LES-7 systems are composed of an HTTP server, inference gateway (CGI program), server with inference engines and man-machine interface (Figure 6)¹⁵. The inference engine is a meta-interpreter

Figure 6



written in Prolog to infer with CPF directly. A CPF rule file, a goal file and board numbers of socket are given in it at the beginning and it is permanently stationed after starting. The meta-interpreter is called for requirements from the process on network through socket communication and it can return the results of the inference. The inference engine is separated from the CGI program (gateway) and the interface is composed of socket communication, so that the independence of the programs is promoted. The program source is written in SICStus prolog, so that it is valid independently on special platforms.

I would like to introduce the reader to the system, showing and explaining pages of the system. The system has a Japanese version as well as an English version. Figure 7 is the main menu of the LES-6 system¹⁶.

In this page, we can choose the law to be applied under the theories according to which the knowledge is formalized. Here we can also choose the consulting case-problem. We may preview the chosen case, modify it or create a new case. Figure 8 shows an outline of the chosen Case 8f,

Figure 7

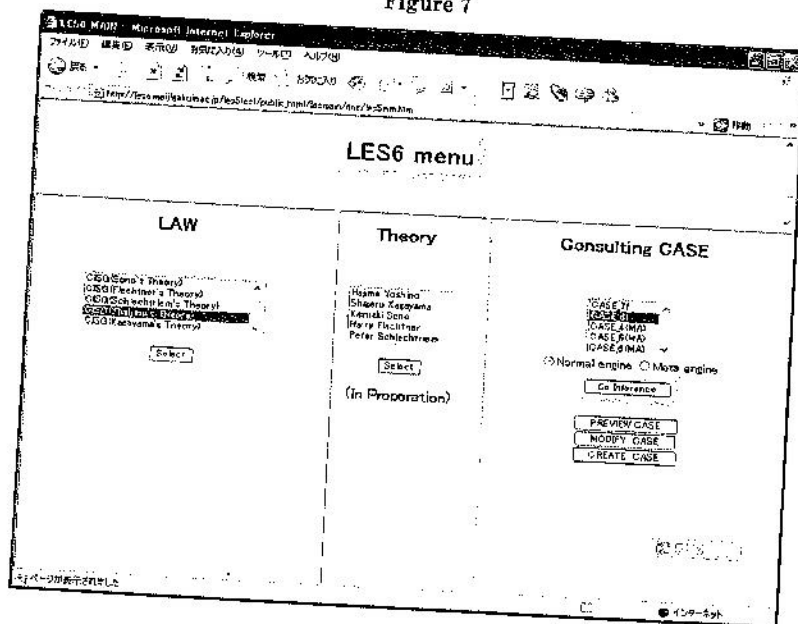


Figure 8

CASE 8f

1. On April 1, a New York manufacturer of agricultural machines, A (Anzai), dispatched to the Hamburg branch of a Japanese trading company, B (Bernard), a letter containing the following proposal: A will sell B a set of agricultural machines comprised of a tractor and a rake; the price of the tractor is \$50,000; A will deliver the machinery to B by May 10; B must pay A the price of the machinery by May 20; the machinery will be transported by an American freight vessel.
2. The proposal reached B's letter box on April 8.
3. On April 9, B telephoned A and said, "I accept your offer. However, I want the machinery transported by Japanese container ship."
4. A delivered the agricultural machinery to a Japanese container ship at the port of New York on May 1.
5. The machinery was delivered to B's Hamburg branch on May 31.
6. B examined the machinery on June 5.
7. B paid A \$58,000 on May 20. (The market price of the rake was \$8,000).
8. On August 10, the machinery malfunctioned because of a defective connecting gear.
9. B notified A of the malfunction immediately.
10. On September 1, B demanded that A repair the lack of conformity within

which is described earlier in this paper.

In the LES-6 menu, i.e., in the Fig. 7, if we click 'Do Inference', we are given the 'inference' page where we may choose the "goal list" or the "Legal Figure of the Case". If one chooses the former, then a list of goals is given which should be resolved by the system is shown. If we choose the latter, Figure 9 and 10 appear. This figure is a belt figure which represents movements of the validity of legal sentences which describe duties or rights of both parties of the contract. Thus, this represents changes of legal duty and right relations between parties in the given case-problem according to time progress. If we look at what kind of belt with sentences are represented at the right side of the date, for example "4/15", then we can identify what legal sentences are valid at the time point, that means what kind of right and duty relation exist between A and B on the date. Clicking a date of the left column, we can let the system explain the reason why such legal sentences are valid on the date.

If we click, for example, the belt figure which represents the validity of the legal sentence "A (Anzai) is obligated to remedy the lack of conformity of the goods by repair," then we can confirm the reason why the sentence becomes valid on September 1st and is terminated at time October 10th.

Figure 11 shows that the legal sentence "A is obligated to remedy the lack of conformity of the goods by repair" become valid on September 1st, because B (Bernard) claims A that A remedy the lack of conformity of goods by repair at time September 1st and the legal sentence "It is entitled for B that B claims A that A remedy the lack of conformity of goods by repair" is valid at time September 1st.

In the Fig. 11, if we click rule ID "3aa2", then we can confirm the legal rule sentence applied, that is shown in Figure 12. This rule regulates the relation between right and duty as mentioned above [4.2.2].

If we click "See" in front of the sentence "It is entitled for B that B claims A that A remedy the lack of conformity of goods by repair" is valid at time September 1st" in the Fig. 11, then we can confirm the reason why

Figure 9

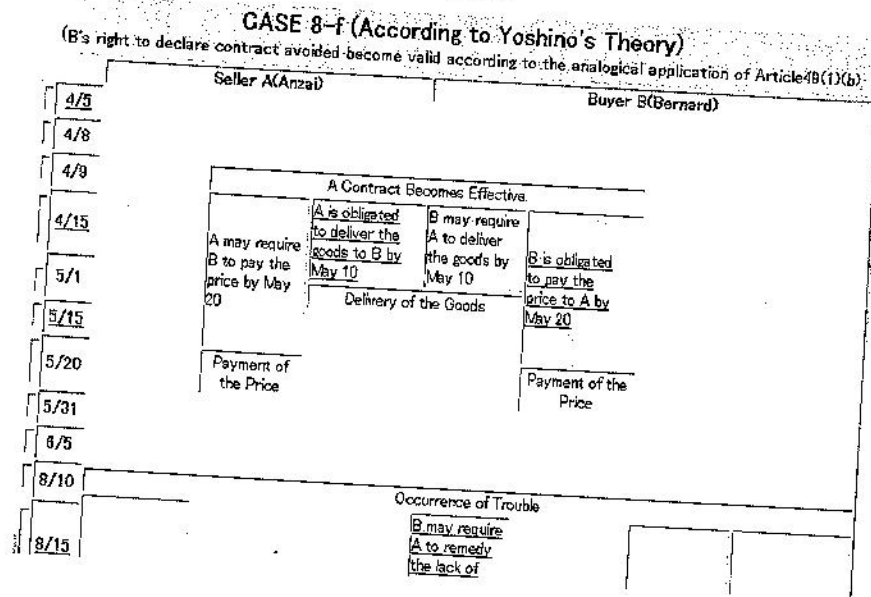


Figure 10

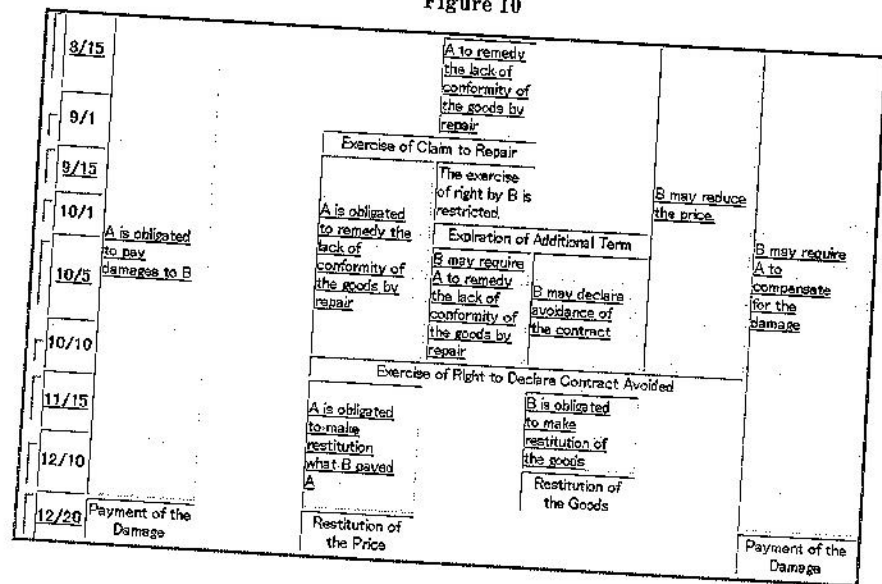


Figure 11

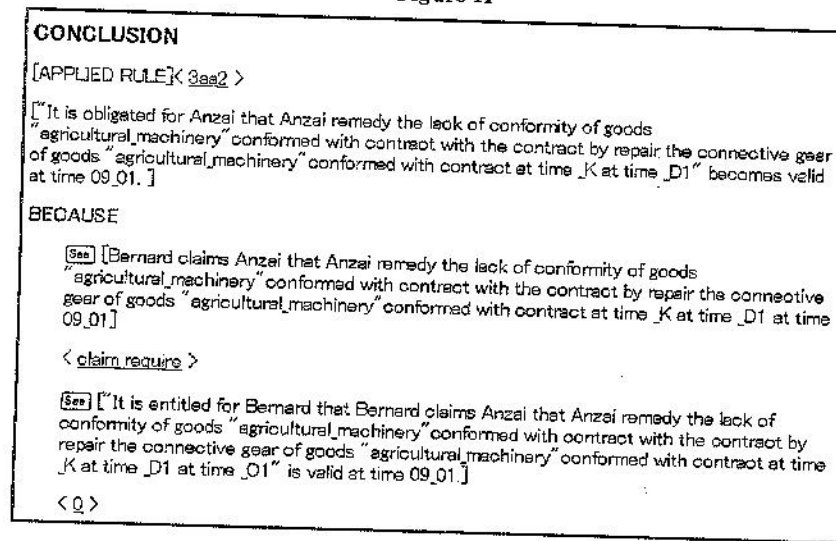
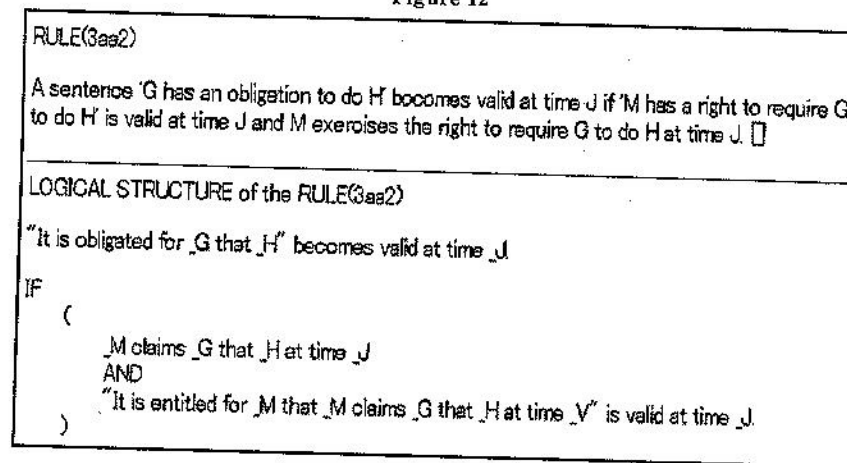


Figure 12



this is proved as true, in Figure 13. This is the result of the application of rule 0.

Clicking rule ID "0" in Fig. 13, we can confirm the rule applied, which is the fundamental meta rule sentences mentioned above [4.1]. Figure 14

shows it.

We can confirm the reason why the first requirement of rule 0 "It is entitled for B that B claims A that A remedy the lack of conformity of

Figure 13

CONCLUSION

[APPLIED RULE] < Q >

["It is entitled for Bernard that Bernard claims Anzai that Anzai remedy the lack of conformity of goods "agricultural_machinery" conformed with contract with the contract by repair the connective gear of goods "agricultural_machinery" conformed with contract at time _M at time _F1 at time _G1" is valid at time 09_01.]

BECAUSE

["It is entitled for Bernard that Bernard claims Anzai that Anzai remedy the lack of conformity of goods "agricultural_machinery" conformed with contract with the contract by repair the connective gear of goods "agricultural_machinery" conformed with contract at time _M at time _F1 at time _G1" becomes valid at time 09_10.]

< 3AA2A3A >

NOT & has succeeded.

is_terminated2 AND

time_after AND

Figure 14

RULE(0)

A sentence E is valid at time G, if E becomes valid at time J before G and it is not the case that E is terminated after J and before G. □

LOGICAL STRUCTURE of the RULE(0)

"E" is valid at time _G.

IF

(

 "E" becomes valid at time before _G.

 AND

 NOT

 (

 _E is terminated2 at the time _M

 AND

 (

 after _J

 AND

 before _G

)

)

)

goods" becomes valid at time August 10th, if we click "See" in front of the sentence in Fig. 13. In this way, we can confirm the reasoning processes as well as the legal knowledge applied to solve the problem step by step precisely.

6. The Applicability of the Legal Knowledge Base System to Legal Education

Our system has the capability to show the legal knowledge and legal reasoning process in its details on the one hand and systematically on the other hand, especially in terms of relationships between the legal requirements and legal effects in each legal rule and relationship of legal rules, including meta levels of rules through which right and duty relation is correctly represented. The system is, therefore, useful for law students to understand legal knowledge in its details as well as its systematic structure. It is also useful to analyze knowledge and to develop individual systematizations of the knowledge.

The system is applicable to legal education in general in two directions: student's acquisition of fundamental as well as concrete legal knowledge or skills of law on the one hand and promoting student's creative legal thinking on the other hand.

I would like to give a list to explain at first in the first direction and then in the second direction.

- (1) As an acquisition of fundamental as well as concrete knowledge/skills of law, the following dimension can be listed:
 - (1.1) Understanding general logical structure of legal knowledge and legal reasoning.
 - (1.2) Understanding concrete knowledge structure of positive law and reasoning of legal problem solving.
 - (1.3) Simulation of legal reasoning and legal problem solving and
 - (1.4) Developing skills to write the reason why the problem is to be solved so.

(2) Promoting Creative Legal Thinking:

- (2.1) Comparison of theories or cases through problem solving,
- (2.2) Simulation of hypothesis generation and falsification and
- (2.3) Learning of systematization and concretization of legal knowledge constructing one's own legal knowledge base.

We have tried to apply our legal knowledge base system to our practical teaching in the classes of "Legal Methods", "Legal Informatics" and "Law and Artificial Intelligence" at Meiji Gakuin Graduate Law School, where the education for professional lawyers are to be developed and at Keio University Graduate School of Law, where legal researchers are to be educated. The purposes of the application of the system to the classes are:

- (a) to understand the general structure of legal knowledge and the reasoning process,
- (b) to understand the concrete content and the structure of legal knowledge and reasoning process to solve given problems,
- (c) to exercise to write the reason why the conclusion is deduced and
- (d) to analyze the CISG and write student's own legal knowledge base for understanding the structure of contract law.

As regards (a), it was confirmed that the application works to let students understand the general structure of law more clearly than traditional oral lectures. As regards (b), it worked to let students catch the real function of legal knowledge to solve concrete given problems. As regards (c), it worked for students to get the way of writing the syllogistic reasoning structure and contents more clearly, precisely and effectively than traditional exercising methods. As regards (d), students could develop their creative thinking capability to analyze and systematize law¹⁷.

I would like to add some comments on the efficiency of use of visual representation introduced above. It is indeed the case that the visual representation of changes of legal relations of cases as the belt figure of the validity of legal sentences and reasoning processes step by step in the explanation windows help students to understand the knowledge and

exercise the skills to use it.

It can be said that our results confirmed the use of the legal knowledge base system especially for (1.1)-(1.4) and (2.3) mentioned above.

Conclusion

In this paper, we demonstrated basic concepts in Logical Jurisprudence, representation of changes of legal relations, legal meta sentences which decide the validity of legal sentences, a case-problem related to the CISG as an example for our discussion, the representations of legal knowledge in legal knowledge base systems (LKBS, LES-6 and LES-7) and the applicability of LKBS to legal education. We have shown that our logical model of law and its implementation in LKBS (LES-6 and LES-7) is useful for legal education, including its visual representation.

We would like to conclude this paper giving some comments on our present and future tasks. In this paper, we have discussed legal knowledge as well as reasoning mainly in terms of the reasoning of justification. We should also discuss the reasoning of legal creation. The knowledge structure of legal creation and the methods of education for it will be discussed more precisely on another occasion. It is to be noted that for such works it is indeed needed as their necessary condition to clarify and reconstruct the deductive structure of legal knowledge and legal reasoning, because the legal creation is performed in the framework of the legal justification which is constituted of deductive reasoning.

The present visual figure of changes of legal relations is not automatically drawn but with coding. The content of the legal sentences which describe obligation or right and the beginning point as well as the terminating point of the validity of the sentences can be inferred automatically by our LKBS, if we let the LKBS solve a query as to what kind of legal obligation or right sentences become valid and are terminated as a result of the application of the CISG to a given case-problem. The time when a legal sentence becomes valid corresponds to the beginning point of its

belt figure and the time when the legal sentence is terminated corresponds to the terminating point. The period between the beginning point and the terminating point constitutes a belt. Therefore, it is possible to make a program to display the belt figure of the validity of legal relations automatically. We are now going to construct such a system. This is one of our near future tasks.

Acknowledgements

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Notes

- 1 At first, the legal knowledge base system LES-5 was developed in 'Legal Expert' Project. It is a Japanese project on the development of a legal expert system, which has been funded by the Japanese Ministry of Education, Science and Culture. The author, as the representative, organized over 30 lawyers and computer scientists to clarify legal knowledge and develop legal expert systems. Regarding the project and its study results cf. two special issues of *Journal of Advanced Computational Intelligence*, Vol. 1, No. 2 (1997); Vol. 2, No. 1 (1998) and also cf. the special issues of *Artificial Intelligence and Law* 5 (1997). The system is in the mean time through the new project developed to LES-6 and LES-7. The application of the systems to legal education is performed.
- 2 The difference between conventional and legal sentences and how these differ is discussed later [4.2.1].
- 3 Cf. ref. 22, p. 3; ref. 23, p. 4.
- 4 Cf. ref. 8, 299-301; ref. 23, p. 4.
- 5 The systematization of law has been endeavored especially in continental law countries. Scholars of modern natural law, such as H. Grotius, S. F. v. Pufendorf, and B. de Spinoza have tried to present the natural law system as a deductive system such as geometry. Legal scholars of general theory of law in Germany, such as F. R. Bierling and K. Bergbohm, have tried to explicate

positive law as a deductive system. From a strictly logical point of view, however, they did not succeed in presenting a legal system as deductive.

- 6 Interesting works on law and legal reasoning modeling have been published; ref. 2, 3, 6, 7. Our study developed independently of them. Our approach is different from van Kralingen's approach, for example, in that it is not conceptual or frame-based but purely logical, especially in that we analyzed and reconstructed the law logically intensively in 'legal sentences,' 'their validity' and 'logical deduction.'
- 7 We have already done this to a certain extent, i.e., ref. 9, 17 and 23.
- 8 Cf. Kelsen 1960, ref. 5, p. 109. Kelsen proposed the concept of "basic norm (*Grundnorm*)."⁸ It is to be noted that my basic concept of the legal rule sentence does not always coincide with Kelsen's conception. They differ in the following points: Kelsen depends on legal norms as a meaning, while I depend on legal sentences; Kelsen's basic norm is conceived of one as which takes for granted as a given positive law, while my theory presents not only such a basic legal rule sentence but also fundamental rules which are always applied in any case where the validity of a legal sentence is to be decided. This has become the case of our logical analysis of legal systems and legal reasoning.
- 9 The validity of this fundamental legal meta rule is presupposed. In the CISG knowledge base a sentence which describes this validity is set as a legal fact sentence.
- 10 We could say, therefore, that all legal meta rules in this sense contribute to regulating the validity of legal sentences.
- 11 The negation as failure is a concept in logic programming, where the negation of a sentence is considered true if it is failed to prove that the latter is true.
- 12 As to the identification of this legal rule and the formalization of the inference process of the creation, we have discussed in: ref. 8.
- 13 This reasoning can be done through the analogical application of article 49 (1)(b). I would like discuss about this analogical reasoning in another occasion.
- 14 On the logical foundation of CPF cf. ref. 21.
- 15 Figure 6 as well as relevant explanations are written by my colleague Seiichiro Sakurai.
- 16 LES-6 is developed by the auther being cooperated with Seiichiro Sakurai.
- 17 Cf. ref. 9, ref. 23.

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