SESSION 4B

PAPER 1

AUTOMATION IN THE LEGAL WORLD

by

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BIOGRAPHICAL NOTE

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AUTOMATION IN THE LEGAL WORLD

FROM THE MACHINE PROCESSING OF LEGAL INFORMATION TO THE "LAW MACHINE"

by

DR. LUCIEN MEHL

INTRODUCTION

I. It may seem an ambitious step to try to apply mechanization or automation to the legal sciences. However, a machine for processing information can be an effective aid in searching for sources of legal information, in developing legal argument, in preparing the decision of the administrator or judge, and finally in checking the coherence of solutions arrived at.

(a) Introducing mechanization in a field of this kind is a particularly complex task, and imposes heavy obligations. In the first place, much preliminary work is needed for introducing automation in legal affairs, and so much work can only be decided upon if it is found to be of definite use. Secondly, such an undertaking is not without its risks; the jurist may lose direct contact with the sources of law and no longer have the benefit of the intellectual activity involved in searching for information. Lastly, as a result of mechanization of this kind, thought may itself become inflexible, diminishing creative power and innovative effort.

Nowadays, however, machine processing of information is becoming essential; "Homo sapiens" is in fact exposed to the risk of being overwhelmed by the vast accumulation of knowledge. It is becoming increasingly difficult to gain access to the sources of ideas, and the researcher wastes valuable time and often intensive mental effort in detailed and unprofitable research, never being sure whether his investigations will be fruitful, or whether he will not by-pass the essential information. Moreover, it happens that writers doing research in the same field of knowledge are unaware of one another's work; and besides this, the difficulty of finding the information required makes the researchers specialize still more. They find it hard to link up the different disciplines, because they are generally doomed to remain in ignorance of everything outside their own customary field of investigation.

Even within a well-defined field of knowledge such as law, the researcher is frustrated in advance by the vast accumulation of information sources. In legal matters, the number of laws and regulations and the scope of jurisprudence are growing on an alarming scale, and everyone is complaining about the situation - administrators and judges, as well as those dealt with under the law.

Thus the researcher, like the man of action, runs the risk of being confined to partial views, just at a time when works of synthesis are becoming more and more necessary in the modern world. Indeed, it is no mere chance that during recent years, the new methods proposed to theoreticians as well as to persons engaged in practical affairs all show a concern for synthesis (cf. the use of models, analogous argument in cybernetics, operational research, etc.)

It is, therefore, desirable to mechanize information retrieval, which must be speeded up, made more complete, more reliable and lead to synthesis in documentation.

The spare time created by such mechanization can then be devoted to research proper, to true scientific thought.

(b) It is likewise possible to some extent to mechanize processes of reasoning in the social sciences, especially in regard to the legal aspects. The aim must be not only to make available to these sciences the powerful tool of mathematics (especially its new aspects), but also to perfect and systematize logical argument, at least for problems whose solutions can be derived unambiguously from the data (thus this would not rule out synthetic control by humans, because the solution to a legal problem may depend upon extra-rational factors, involving the whole of human experience).

II. However, if information retrieval, and indeed logical argument, are to be mechanized, the problem of mechanizing logic must be solved first. The dream of Raymond Lulle, who mentions this possibility in his "Ars Magna"; of Descartes, who investigated the general processes of reasoning in his "Discourse on Method"; of Leibnitz, with his idea of a universal characteristic, the mechanization of logic is possible today, and has even been realized in certain respects, as demonstrated by M. Couffignal in his work "Les Machines a Penser" (Thought Machines). In fact, on the one hand logic has itself made definite advances: we now know enough about the laws of thought, and we have a better knowledge of the analysis of reasoning. Boolean algebra offers us a convenient system of symbols in this respect. On the other hand, it is possible to combine it with binary notation, which is admirably suited for analytical purposes.

In addition, this progress in knowledge has been accompanied by improvement in techniques. Not only have our methods of classification and selection been improved: punched card systems and - to a still greater extent -

modern computers, already offer us the elements of solutions. The latter, in particular, have a great capacity for storing information with relatively quick access; flexible programmes can be fed to them, including not only directions connected with mathematical operations, but logical instructions as well.

The problem of making a "law machine" certainly involves a technical aspect. It will be necessary to find the type of machine capable of fulfilling this function, to determine the essential features of such a machine. However, any machine suitable for making selections will generally be suitable to a greater or lesser extent. The problem is thus essentially a theoretical and logical one. For solving it, we require more highly-evolved analysis of legal concepts than that to which we are accustomed, conducted in a different spirit, in some cases. It invites us to define new legal concepts which will combine easily and unequivocally.

III. One may imagine two basic types of law machine:

(1) the documentary or information machine, or - in more familiar terms - the machine for finding the precedent (or relevant text),

(2) the consultation machine; less properly, the "judgment machine".

There is no fundamental difference between these two types of machine; the difference is one of degree rather than of essence. The consultation machine will give an exact answer to the question put to it, whereas the information machine will only supply a set of items of information bearing on the problem. Conceptual and relational analysis is more acute in the consultation machine; its structure is more delicate, the network of information is more finely woven.

In addition, this machine may be called upon to verify the logical coherence of the legal provisions of laws or conventions.

Finally, the analytical work needed for making these machines may supply the essential elements for developing a machine for translating legal texts.

The present study will, however, be confined to the first two types of law machine.

I. MACHINE RETRIEVAL OF LEGAL INFORMATION(*)

1. *The Usefulness of an Information Machine*

Machine information retrieval is thus the first stage in mechanizing juridical activities, involving searching for the relevant text, the jurisdictional precedent or doctrinal studies.

(*) Here we shall speak of "automatisation" or "mechanization" rather than of "automation" in the strict sense of the term. The latter really implies continuous processes, without human intervention, and is more a dream of the future than an immediate prospect.

The primary advantage of such mechanization is to remedy the difficulties arising from the multiplicity of legal sources; the law may be international, national or local; it may be expressed in treaties, laws, decrees, regulations, orders in the legal systems of law courts and administrative courts, in the principles laid down by governing bodies (circulars and instructions), and in those of writers, (treatises and reviews).

If it covers a sufficiently wide field, mechanization can also be an aid in collecting easily, and without error or omission, the items of information bearing on legal situations, for solving which a knowledge of precepts falling within different branches of the law is required. For example, assessment of the legal situation of a company director leads to investigations into commercial law, civil (or social security) law and fiscal law. In this connection, a machine could make comparisons which would not have occurred to man, reveal incoherencies or contradictions which would not otherwise have been disclosed, and lastly initiate original solutions, so as to advance legal science and equitable applications of the law.

2. *Principles for Machine Information Retrieval*

We already know that the mechanization of information retrieval involves a problem of developing concepts and relationships, much more than being a technical question. It requires a series of analyses and syntheses to be carried out within the mass of legal information.

(a) First of all, the legal information has to be set in order. The ideal way of doing this is to codify(ø) the sources of the law, whether they be legislative or statutory texts or texts of jurisprudence. This is not absolutely essential, but in any case it is necessary to set the information in order, following the general principle that rationalization must precede mechanization. One will then set about establishing the basic concepts and their relationships, which can be expressed by means of a juridical algebra which will facilitate the process of encoding.(*)

(b) The basic concepts are elementary legal notions, the combination of which will enable all possible situations to be defined, in principle.

(1) Determining these elementary concepts is obviously the most delicate part of the preliminary work for machine processing legal information.

However, we find an initial step towards this in the legal vocabulary, certain expressions of which constitute the tables of law compendiums. These expressions, which are intended to make reference to the tables or indexes easier, are sometimes called "key-words" or "guide-words".

(ø) "Codify" here applies the collection and integration into a single document, of texts bearing on a branch of the law, presented according to a rational scheme called a "code".

(*) By "encoding", we mean here the transcription of legal information into a conventional script which can be used on the machine.

In general, however, the key-words - established on an empirical basis - cannot be regarded as true basic concepts. Indeed, the legal vocabulary is often ambiguous. This will be found to apply to the word "droit" itself, which in French can mean legal science, a faculty or prerogative or again, certain dues. In view of this diversity of meaning of the word "droit", one is inclined to reject it as a basic concept without any further investigation. The word "acte" is equally ambiguous, meaning either the legal action (actum juris), or the legal document (instrumentum juris).

In addition, the language of the law is burdened with synonyms, such as "offer" and "pollicitation", and furthermore these synonyms may cover nuances which are sometimes imprecise and of doubtful use. For example: limitation, expiration, foreclosure, prescription; or again, annul, repeal, rescind. The legal vocabulary sometimes becomes paradoxical. In French, the members of a "société" are "associés", but the members of an "association" are "sociétaires". It will be seen already that it is essential to give the words a single proper meaning, and eliminate synonyms.

(ii) Besides, the usual legal vocabulary, in particular, is too complex and too rich. A single word covers a vast amount of information and cannot generally be regarded as an elementary concept. In most cases, the elementary concepts cannot be defined by a single word or phrase.

Moreover, experience and reasoning show that the number of elementary concepts is relatively small, and that with a small number of well-chosen concepts, it is possible to cover all institutions and situations. Such reduction of the basic concepts to an elementary form will enable the simplicity, speed in operation and efficiency of the machine to be increased.

This idea may be expressed more specifically by reference to the exponential law of information. The data, notions, situations or problems capable of being expressed in basic concepts, affirmed or denied, increase according to a dual exponential function, whereas the concepts themselves increase in arithmetic progression.

Thus with two basic concepts, affirmed or denied, 4 logical combinations can be constructed: 2^2, or, in binary notation, 00,01,10,11. These combinations can themselves be linked up to form 16 logical functions: 2^{2^2}, or, in binary terms:

	00	01	10	11
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

Let us consider, for example, the two binary concepts, man-woman (H.F.) and single-married (C.M.) There are 4 possible combinations:

FC	HC	FM	HM
00	10	01	11

The logical function *man* becomes:

0 1 0 1

and the logical function *woman:*

1 0 1 0

The aggregate of single people is represented by the function:

1 1 0 0

The aggregate of bachelors and married women becomes:

0 1 1 0,

etc.

We thus finally get a form of super-encoding in binary notation, which will enable *all* the logical functions obtained from linking up the concept combinations to be realized (whereas the mere encoding of combinations offers only limited possibilities).

With 3, 4, 5, 6 basic concepts, we get the following table:

Basic concepts	*Logical combinations*	*Logical functions*
3	$2^3 = 8$	$2^8 = 256$
4	$2^4 = 16$	$2^{16} = 65,\ 536$
5	$2^5 = 32$	$2^{32} \approx 4.10^9$
6	$2^6 = 64$	$2^{64} \approx 16.10^{18}$

One can see the rate at which the number of logical functions increases when the number of basic concepts is increased by a few units.

(c) Unfortunately, the method of developing the concepts is rather a laborious one, requiring systematic exploration and analysis of literature in the branch of law concerned. First of all, one assembles a number of key-words or ideas for guidance; then by successive approximations one can obtain concepts which become more and more exact and simple as the material is arranged in order.

It must be emphasized that "elementary concept" does not mean "rudimentary concept". The elementary concept sometimes expresses an extremely pregnant and significant idea, and it very often bears close affinity with its cognate words. In the field of chemistry, it may be compared with the atom, which is no less complex than the molecule, of which it is a part.

1. Sometimes the breakdown is direct "Lease" can easily be replaced by "contract for the hire of property" - a grouping of simpler terms; "articles" by "deed of partnership", etc. However, the first terms will frequently not exist (i.e. suitable words will not be available in the current language). It may be useful to express them by symbols, because if expressed in current language, they may be rather long. In fiscal law, for example, the word "contribuable" (taxpayer) which has "redevable" and "assujetti" as synonyms, is not necessarily a basic concept and it may be advantageous to use the following notion: a person or body corporate, subject to a fiscal obligation, either as a payee (receiving an income for example) or as a payer (paying a salary, for example). Moreover, it can be seen to be a binary concept. Regarding taxes on income, the binary concept "value received or given", or "appreciation or depreciation" of assets (since in French fiscal law, accrued values are in principle subject to tax) should be used in preference to "profit", "benefit", "income".

In the same way, the word "marriage" is not a basic concept in civil law. There seem to be grounds for retaining the concept of *"union"* which in association with others will evoke marriage, company mergers, communal groups. One might also find that there is a concept *"division"* (divorce, separation, splitting of municipal area, secession of territories, etc.) and a concept *"cessation"* (decease, cessation of an undertaking, winding-up of companies, etc.)

2. Moreover, it must be emphasised that the idea of an elementary concept is only a relative one. The analysis will have to be more detailed if great precision is desired, when an attempt is made to apply mechanization to a very extensive field. For the information machine, *slight* analysis will suffice, whereas the consultation machine is more exacting. In any case, the concepts must always be chosen in terms of the constituent elements of the problem under consideration, the question posed, and not in terms of the solution or answer deemed to be the unknown.

3. The advantage of binary concepts is that they are not only suitable for encoding; they may conveniently be combined with other series of concepts which do not have to be repeated in the memory of the machine, as well. For example, for the concept "person subject to a fiscal obligation" one will have only a single list of the different persons or bodies corporate, whether they be payees or payers. In the case of the concept "value given or received" there will only be one list for these different values, the lists themselves being series of elementary or compound concepts (It will sometimes be necessary to use ternary, quaternary concepts, etc.*)

(d) In the information machine, the combinations of, and relationships between, concepts are very simple. Whereas in a consultation machine all the logical functions have to be used, especially implication, two functions suffice here: conjunction or logical product of concepts, expressed in current language by the word "and", and disjunction, expressed in current language by the word "or". Conjunction and disjunction suffice to bring about the combinations and relationships of concepts defining the various legal situations.

3. *Designing the Machine*

(a) Any machine capable of selection can be adapted for machine information searching.

1. The first stage of the information machine is the card-index. Sets of information, encoded if necessary, are recorded on the cards. The card-index is an improvement on the book, the code or the table. It can easily be brought up to date by withdrawing or adding items, and the classification can be changed if necessary. In this way, the *mobility* of the basic information is ensured.

2. The second stage consists of using laterally-punched cards (selection by rods) or cards with general punching (visual selection). The card-index can then be consulted without any strict order for operating concepts being imposed: selection thus becomes *commutative*, and is speedier as well. In addition, there is no reason in principle for bothering to reclassify any cards which may be put back loose in the card-index.

3. Lastly, electro-mechanical processes (punched card systems) or electronic processes (computers) can be used. Selection thus becomes *automatic* and we can then speak of an "information machine".

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* See Part II.

(b) The contents of the elementary document will vary according to the process used.

1. First of all, a card can be made out for each reference unit (clause of an act, legal decision, doctrinal study). The punch-holes in the card, or the recording on the magnetic tape correspond to the essential characteristics, i.e. to the basic concepts applied in the reference unit concerned.

With the manual, visual, and even punched-card selection systems, it is possible to have the legislative text or legal award, etc., recorded on the basic document, card or microfilm, allowing just a summary to be used. An electronic computer, on the other hand, will normally only give references (printed in plain language), and it will be necessary to refer to codes, digests or card-indexes.

2. One can thus apply the method of using one card for each fundamental idea or basic concept. The reference which covers the idea or concept concerned is defined by its co-ordinates and marked on the card by a small perforation. To find the reference (text or award) corresponding to a set of concepts, the cards relating to these concepts are superimposed. The references can be seen in the form of points of light. The advantage of this system is that no strict systematic arrangement of the concepts or complex codification is needed (Selecto system).

(c) The choice of technique will depend upon the extent of the legal field concerned and upon the requirements of the service, account being taken of the information capacity and selective speed of the various items of equipment.

1. The hand-sorted cards with lateral perforations allow 100 (4 x 25) elementary items of information to be recorded, which represents only about 6 basic concepts (with 128 perforations it would be 7). The number of concepts can be raised to 36 if they can be split up into 12 independent series of 3 concepts.

The visual-selection cards have a greater capacity (e.g. Filmorex, 20 x 28 = 560; Kodak 42 x 70 = 2,940), and the scope of the Selecto system seems to be of the same order. Adoption of card-indexes of this kind is in itself a definite advance.

The ordinary punched card-indexes have an intermediate capacity of 800 (80 x 10), but they have speedier selection.

As for the capacity of the great electronic units, it is practically unlimited.

2. The speed of selection must be taken into account. With hand-sorting, 12,000 cards can be dealt with per hour; 36,000 with visual selection and 60,000 with punched card selection. The selective speed of computers is beyond comparison with the speed of these systems (900,000 - 1,200,000 characters per minute).

3. It can thus be seen that if the amount of material to be recorded is large (and this is the case with legal material, owing to the accumulations from the past), automatic processes are needed.

The punched card system is not itself very satisfactory, as demonstrated by the test carried out in the Supreme Court of New Jersey (U.S.A.): Selection covered 180,000 cards on jurisprudence and the waiting period (maximum) was up to three hours, definitely longer than traditional procedures take.

Remedial measures can no doubt be found, such as dividing the card-index into relatively homogeneous and independent sections, which in some cases will enable the selections to be confined to a single section (but then the benefit of fully automatic operation and the possibility of comparison and cross-checking between the different sections is lost). We thus find that if it is desired to speed up searching for the required information, electronic processes must be adopted when the equivalent of 100,000 punched cards is exceeded. Exploration of the memory is thus infinitely more rapid, particularly when such exploration may not be exhaustive, if the memory is partially "addressable".*

(d) Mechanization of legal information thus leads to a certain amount of centralisation.

With manual or visual processes, this centralisation is confined to the study of concepts. This is done by a single team of specialists, which constitutes an "intellectual investment"; the cards can then easily be reproduced and distributed among subscribers.

With an electronic computer, however, it is the work of consultation itself which is centralised. Owing to the cost of such a machine, automation of legal information can only be undertaken on a national level. The machine could be installed at a legal information centre linked by teleprinter, or some other convenient means, to Parliament, to the principal courts and the major administrations. Capacity use would thus be ensured, and it would certainly be profitable, in view of the working time made available.

4. *Advantages of the Legal Information Machine in Greater Detail*

In the further discussion below, we shall assume that we have at our disposal a keyboard machine (digital); in effect, a computer.

(a) On the keyboard of the machine a concept will occur once only, whereas in the analytical table of a digest the key-words must be repeated.

Let us consider company law, for example. Under each of the headings, formation, dissolution, prorogation, etc., we shall find the following sub-sections in the analytical table:

private company, limited partnership, limited liability company, joint-stock company, etc.

But each of these sub-headings will occur as a keyword in its alphabetical or logical place in the table, the key-words themselves becoming sub-headings. One will see the following, for example:

* The electrostatic memory recently invented by the French engineer Edgar Nazare seems to meet the requirements of the law machine (memory based on a register system and binary notation, addressable and practically unlimited).

Limited liability company

formation

dissolution

prorogation etc.

It will be seen that, if the number of key-words is m, the complete table will contain $m!$ lines (assuming that all the permutations are valid). If the table is divided up only into headings and sub-headings, it will still contain $m(m-1)$ lines.

A keyboard of elementary concepts would thus allow a considerable amount of simplification.

(b) A second advantage of the machine lies in the fact that for the purposes of consultation the concepts may generally be taken in any order, especially when the question posed consists simple of a conjunction of concepts. If it is a keyboard machine, no specific sequence for striking the keys is required. With the digest tables which cannot give all the permutations, on the other hand, a certain sequence must be followed, involving the risk of wrong selection. In other words, with the information machine, the operation of selection is made commutative, and the machine reduces the maze to be searched.

Furthermore, by using fewer concepts than the number defining the problem posed, one obtains information on more general situations. By substituting one concept for another, information on closely-related situations can be obtained.

(c) A certain amount of training will undoubtedly be required for using the machine. The operator will have to know the unnamed concepts and the way to combine them. Only a minimum of preliminary training will be needed, however. Moreover, a table of definitions for the unnamed concepts can be supplied with the machine. A dictionary for translating the common concepts into basic concept combinations may be conceived as well. The word "dictionary" brings out well the idea that the jurist using the machine will have to learn a new language.

Furthermore, the effort of defining and using new concepts will lead to progress in legal science, owing to the heuristic value of analysis and synthesis carried out according to procedures different from the traditional methods in law.

Thus Mr. Aurel David - who has done work on the foundations and symbolization of civil law - was able to reduce all the contracts to sale and hire. Whence we get a more precise conception of what is truly human in man. His capacity for work, his intellectual power, is no part of his actual person, since under certain conditions it may be made the object of a contract *(ref. 3)*. Moreover, the present writer has reached the same conclusion in analyzing in fiscal matters the notion of income, which in every case comes from one source: capital, which may be either a material good, or the physical strength or aptitudes of man.

II. AUTOMATION OF LEGAL ARGUMENT

One may conceive of a machine capable of providing an exact answer to a problem put to it, and not merely a set of information on the problem. Development of such a machine required more detailed analysis of the concepts and the application of relationships more complex than those of the information machine.

1. *Principles*

(a) Automation of legal argument can be achieved in two forms:

1. One may merely mechanize a limited process: the machine will then provide a decision within a highly specialized field of law.

One may, for example, imagine automatic invoicing with the aid of punched card techniques consisting chiefly of the calculation of taxes on turnover applicable to the various products sold, according to their nature and intended purpose or destination.

2. One may also conceive - more ambitiously - a consultation machine which will answer any question put to it over a vast field of law.

Such a machine will obviously be more complex than the previous one, but according to the exponential law of information, its complexity will increase much more slowly than the volume of legal information which it can handle. This means that a machine covering the whole field of law would be simpler and less cumbersome than a series of machines handling separate legal sectors. Moreover, such a machine would be more efficient than all the others together, because it would provide complete and general solutions and would enable interesting comparisons to be made. Whatever the size of the machine, however, the theoretical solutions are the same.

(b) *Elements of the Solution to the Problem.* 1. The consultation machine will first of all require more exact use of specific concepts than the information machine. The latter supplies, in fact, documents or - what amounts to the same thing - references to documents, whereas the consultation machine must provide the solution to a problem. The concepts must thus combine with each other according to a strictly logical system.

2. Moreover, whereas the information machine only uses conjunction and disjunction, the consultation machine needs all the logical functions: affirmation, negation, conjunction, disjunction, equivalence, implication.

3. Let us, therefore, study how these functions can be expressed and handled in binary notation*.

Let A and B be two concepts. Expressing negation by a line above the symbol, we may have, as we have already seen, the four following situations, according as the concepts are both absent from the combination concerned, one of them is present, or both are present.

$$\overline{A}\overline{B} \qquad A\overline{B} \qquad \overline{A}B \qquad AB$$

Representing negation by 0 and affirmation by 1, these combinations can be expressed as follows:-

00   10   01   11

Giving each of these combinations value 0 or 1, according as one of the concepts in them is denied or affirmed, we get a series of logical functions. In particular, A is expressed by

0   1   0   1

and B by

0   0   1   1

The disjunction of A and of B, which we shall express as "$A \cup B$", is defined in binary notation by associating the value 0 with the simultaneous absence of A and B and the value 1 with the other combinations:

A	0	1	0	1
B	0	0	1	1
$A \cup B$	0	1	1	1

The conjunction AB, the case where A and B are both verified at one and the same time, will obviously be expressed by

A	0	1	0	1
B	0	0	1	1
AB	0	0	0	1

Every time we have to combine logical functions, even of an order more than 2 (i.e. derived from more than two concepts) we will know that the function *"disjunction"* being 0111, the resultant logical function is deduced from the functions for combination, by writing 1 when 1 occurs

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* Cf. Louis Couffignal, "Les Machines á Penser" *(ref.2)*. This work gives a precise account of the mechanization of logic, from which we have taken inspiration here.

in any of the functions in the row concerned, and 0 if all the functions in the row include a 0.

It is easy to verify that the process of "*conjunction*" is very simple, as well: the resultant function is deduced from the functions to be combined, by writing 1 when there is a 1 in *all* the functions in the row concerned, and 0 in the contrary case.

The process of implication is more complex. If implication is expressed as $\subset$, we may write:

$$A \subset B = \bar{A} u B$$

If, in binary terms, A is written as 0101, $\bar{A}$ is 1010 and B 0011, hence $\bar{A} u B$ = 1010*u*0011 = 1011.

The function of implication is thus 1011 in binary notation. It means that, in comparing the various rows of the implying function and of the implied function, we must adopt the value 1 to determine the resultant function, except if there is a 1 in the row of the implying function and a 0 in the corresponding row of the implied function, in conformity with the following:

A	0	1	0	1
B	0	0	1	1
	1	0	1	1

If the resultant function only contains a series of 1's, it means that the implication is verified. If it contains at least one 0, it is not verified (see example above).

4. The concepts and relationships can thus be translated into the binary language of the machine, but to arrive at this result it will be necessary to arrange an intermediate stage and use an intermediate language (or rather, script) between the legal language, which remains a human language, and that of the machine. This intermediate script, which must define symbols, will be, as it were, a legal algebra.

Indeed, the need for a system of symbols is manifested every time one wishes to introduce strict logic into a branch of knowledge (e.g. mathematics or chemistry). Symbolism ensures accuracy in expressing basic data and speed in notation. It enables reliable reasoning to be conducted, avoiding any ambiguity in the combination of concepts. But it remains intelligible, whereas the machine binary script is a disconcerting abstraction.

2. *Concrete Example.*

To illustrate our proposition, we shall give an example of mechanization applied to a system of taxation on turnover.

This exercise in fiscal algebra will no doubt appear rudimentary. The concepts involved would admittedly appear to be inadequate for the requirements demanded from the basic concepts, in a more profound analysis. Furthermore, the example is relatively simple, as the concepts in question, affirmed or denied, are 4 in number.

Nevertheless, this example gives an intimation of what might be the way in which a juridical machine will work.

(a) *Account of the System and Equations.* We shall assume that in a given country a system of taxation on turnover is in force, the rules of which are as follows:

The system is cumulative, so that every transaction involves taxation of the overall value of the product.

Any supply of goods by a taxpayer to a person or (corporate) body, whether a taxpayer or not, involves taxation, if it is made within the country, at a principal tax (V_1) the general rate of which is t_0.

The sales of retailers (D), however, are subject to tax at a reduced rate (t-), if they are current products (Pc), but if the same retailers sell luxury goods (P1) the tax is levied at the higher rate (t_+), never charged when the sales are made by a wholesaler (G), whether he be manufacturer or trader.

The manufacturers (F) are subject to the principal tax under the same conditions as the traders (C). However, if they make sales direct to consumers (manufacturing retailers, FD) they pay an extra tax (V_2) at a rate t', in addition to the principal tax at the general or higher rate.

Lastly, exports are tax-free, but if the goods are exported by a trader (i.e. a non-manufacturing person), he gets a refund (R) of the tax levied at the previous stage, as well.

If the items are represented as follows:

$\longrightarrow$	sales
$-\!\!+\!\!\longrightarrow$	exports
S	tax
$\equiv$	the relationship of a necessary and adequate condition,

then conjunction of the concepts being expressed by juxtaposition of the symbols, and negation by a line above the symbol, we get

$$(1)\quad G \longrightarrow \; = SV_1\, t_0$$

$$(2)\quad CD \xrightarrow{P_c} \; = SV_1\, t_{-}^{t}$$

$$(3)\quad CD \xrightarrow{P1} \; = SV_1\, t+$$

$$(4)\quad FD \xrightarrow{P_c} \; = (SV_1 t_0)\ (SV_2 t')$$

$$(5)\quad FD \xrightarrow{P_1} \; = (SV_1 t_+)\ (SV_2 t')$$

$$(6)\quad C \nrightarrow \; = SR$$

$$(7)\quad F \nrightarrow \; = \bar{S}\ \bar{R}$$

It will be seen from this example that it is possible to represent a relatively complex system with a small number of logical equations (7).

(b) *Transcription into Binary Script.* Transcription of these equations into "intelligible" binary script for the machine is a relatively simple matter.

It is easy to confirm that the terms on the left-hand side of the equation only concern four basic binary concepts.

Let us give the arbitary value 0 to one of the series, and the arbitary value 1 to the other.

0	C	D	$\nrightarrow$ P1
1	F	G	$\longrightarrow P_c$

These four concepts can provide 2^{2^4} logical combinations in which they are successively affirmed or denied. Their associated binary numbers are as follows:

F	0101	0101	0101	0101	C	1010	1010	1010	1010
G	0011	0011	0011	0011	D	1100	1100	1100	1100
$\longrightarrow$	0000	1111	0000	1111	$\nrightarrow$	1111	0000	1111	0000
P_c	0000	0000	1111	1111	P1	1111	1111	0000	0000

(c) *Example of the Machine in Operation.* (1) Let us form the logical function which expresses the causes of taxation at the extra tax t'. If u expresses disjunction we get the following in symbolic notation:

$$SV_2t' = (FD \xrightarrow{P_c}) \; u \; (FD \xrightarrow{P1} \quad) = FD \longrightarrow \; ,$$

then effecting conjunction of F, D and

F	0101	0101	0101	0101
D	1100	1100	1100	1100
$\longrightarrow$	0000	1111	0000	1111
FD $\longrightarrow$	0000	0100	0000	0100

(2) Using $\sqsubset$ for the implication function, we now put the question

$$FD \xrightarrow{P_c} \sqsubset SV_2t' \qquad ?$$

We first of all carry out conjunction of the terms of the first part:

F	0101	0101	0101	0101
D	1100	1100	1100	1100
$\longrightarrow$	0000	1111	0000	1111
P_c	0000	0000	1111	1111
FD $\xrightarrow{P_c}$	0000	0000	0000	0100

To find out whether the first part implies the second, we shall combine it with the second part by means of the implication function (1011).

FD $\xrightarrow{P_c}$	0000	0000	0000	0100
SV_2t'	0000	0100	0000	0100

The resulting function is:

1111 1111 1111 1111

since	0	1	0	1
	0	0	1	1
	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
	1	0	1	1

That is, the relationship:

$$FD \xrightarrow{P_c} \subset SV_2t' \text{ is a true one}$$

On the other hand,

$$CD \xrightarrow{P_c} \subset SV_2t' \text{ is false, because}$$

with $CD \xrightarrow{P_c}$	0000	0000	0000	1000
SV_2t'	0000	0100	0000	0100

the resultant function is:

1111	1111	1111	0111

One can see, moreover, that when the machine gives a negative answer it indicates at the same time, by the position of the zeros, *why* the answer is negative. In fact, it is easy to confirm that in order to have a 1 in the thirteenth position, positions 13 and 14 of the first function must be reversed, i.e. manufacturing retailers are involved. The machine thus gives *motivated* decisions.

It will also be noted that if one omits to insert a condition in the question posed, the machine will point out this omission as well. In other words, not only does it motivate its answers; a dialogue may arise between it and the person consulting it, as well.

Of course, in this example, which comprises only 4 basic concepts, the results are almost immediately apparent, which would not be the case with a greater number of concepts. With 20 basic concepts, for example, the machine would provide much less obvious answers and would make its deductions quicker than a human being.

(d) *Supplementary Remarks*. (1) In the foregoing example, the basic concepts are binary. It might be objected that the numerical symbolism adopted is inadequate, if, for example, the concept constitutes an odd aggregate.

In practice, however, one can always reduce a complex concept to a system of conjunction and disjunction of binary concepts.

We shall consider an example:

Let us imagine that we have to transcribe the following three concepts into binary notation:

Manufacturers	F
Farmers	Ag
Traders	N ,

representing the various parties subject to a given tax:

we shall make

$$A_1 = F \cup Ag$$

$$A_2 = F \cup N$$

These concepts, obtained by disjunction, also have a concrete meaning: A_1 represents the producers (agriculture and industry) and A_2 the merchants (commercants) in the legal sense(*) (who in French law include traders and manufacturers, but not farmers).

We then write:

$$A_1 = F \cup Ag = 0101 \text{ producer}$$

$$\overline{A_1} = \overline{F \cup Ag} = 1010 \text{ non-producer}$$

$$A_2 = F \cup N = 0011 \text{ merchant}$$

$$\overline{A_2} = \overline{F \cup N} = 1100 \text{ non-merchant}$$

and then get:

$$F = A_1 A_2 = 0001$$

$$Ag = A_1 \overline{A_2} = 0100$$

$$N = A_2 \overline{A_1} = 0010$$

To this list we may add the taxpayer:

$$A = F \cup Ag \cup N = 0111$$

and the non-taxpayer:

$$\overline{A} = \overline{A}_1 \overline{A}_2 = 1000$$

It may even be useful to draw up a list of all 16 possible combinations which have a concrete meaning.

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* This is why we have chosen here the word traders (negociants) to designate merchants in the usual sense of the term (sellers, not manufacturers).

0000	$A.\bar{A}$	No-one	1111	$A \cup \bar{A}$	Everyone
1000	$\bar{A}$	Non-taxpayers	0111	$A=F \cup N \cup Ag$	All taxpayers
0100	Ag	Farmers	1011	$\overline{Ag}=F \cup N \cup \bar{A}$	Everyone except farmers
1100	$\overline{F \cup n}$	Non-merchants	0011	$F \cup N$	merchants
0010	N	Traders	1101	$\bar{N}$	Everyone except traders
1010	$\overline{F \cup Ag}$	Non-producers	0101	$F \cup Ag$	Producers
0110	$Ag \cup N$	Taxpayers non-manufacturers	1001	$Ag \cup N = \bar{A} \cup F$	Non-taxpayers or manufacturers
1110	$\bar{F}$	non-manufacturers	0001	F	Manufacturers

We thus see what a large number of different combinations can be obtained from two concepts which are affirmed or denied.

(2) One may also note that the order in which the concepts are chosen is immaterial; but this of course assumes that by "concept" we mean a notion with a well-defined function in a system of relationships. If, for example, we write

$$\bar{A} \longrightarrow N$$

(a non-taxpayer selling to a trader),

$\bar{A}$ and N have not the same function as in

$$N \longrightarrow \bar{A}$$

In other words, a notion such as "trader" may cover several concepts (in linguistics, this is the phenomenon of declension). If one wishes to reduce the number of concepts, some order must be assigned to them (as in French or English syntax, whereas in Latin the word-order is optional; at any rate, largely so).

It seems, moreover, that the electrostatic memory to which we have already referred, enables the concepts to be taken in varying order, which may lead to simplification.

More generally, it seems possible to conceive of machines programmed in such a way that the meaning of the words and propositions depends - as in natural language - upon the general context, which would constitute a further advance.

(3) It will likewise be advantageous to divide the field of concepts into separate groups wherever possible. This will also lead to simplification of the machine's communication network, and will enable meaningless combinations to be eliminated, as well.

However, the necessary precautions should be taken so as not to deprive the machine of combination possibilities which might prove significant and useful.

3. *Designing the Machine*

We shall not dwell upon the design processes, the principle of which is the same as for the information machine. Improved equipment is required, however, and this rules out manual systems. Moreover, if mechanization of an independent process can be done by using a punched card system, a consultation machine - to be really efficient - needs an electronic computer with a memory which is largely "addressable".

CONCLUSION

The limits to Mechanization

Whether for the information machine or for the consultation machine, there are obviously limits to mechanization bound up with conceptual difficulties and with the existence of extra-logical factors. The machine is at the most suited to pursue an argument. It is incapable of evaluating data, and "a fortiori" of elaborating the principles of law.

(I) However complete the checking of legal material may be, however subtle the analyses carried out, however elaborate the classifications, it is probable that certain special cases, certain marginal situations will escape the designers of the machine, as demonstrated by the (apparent) paradoxes of the logic of aggregates.

Furthermore, this difficulty is not peculiar to jurisprudence. It occurs, for example, in the natural sciences (classification of species) and even in mathematics, where it is sometimes necessary to discover - for the expression of a function (and particularly for transitions to the limit) - formulations which are at once more exact, more general and more significant.

Besides this, it may happen in law that in certain specific cases, mere application of the principle of law leads to results which are manifestly absurd or iniquitous. It is then for the judge to seek out the underlying significance of the principle, the exact limits to its field of application and, if possible, more exact and adequate expression of the latter.

He will no doubt sometimes have scruples about deviating in this way from the application of the principle: the danger lies in giving way to a pragmatism which may be suspect. However, making judgments often involves departure from strict logic, which is proper to the machine.

(II) To judge is likewise not merely a process of applying the principles of logic. It involves use of all our resources, the totality of human experience, processes which are not wholly conscious but nevertheless valid. It is precisely because we do not know the source and mode of development of the moral principles, legal standards, aesthetic canons that we rely, for making decisions and resolutions, on the comparison of consciences, in the spontaneity of tastes and inclinations *(ref. 4)*.

Furthermore, there is no reason to suppose that these obscure processes of human thought correspond to inferior spiritual states. The contrary is very much the case: a desire to confine one's self to purely rational measures, supposing that this would be possible, would mean condemning one's self to impoverishment of thought, to dessication of the spirit.

Moreover, if the humanities are in some respects tending to take inspiration from the methods of the exact sciences, these latter are paying more and more attention to closed systems, the seat of complex equilibria, whereas in bygone days science analyzed open systems above all. Now it was in the field of the biological sciences and the humanities that the importance of the general and mutual interaction of numerous complex factors was first felt.

Thus although the juridical machine is suited to conduct legal argument, it is incapable of evaluating facts. This task falls to man, because the factual world often defies pure (rational) analysis. Finally, although the machine may be able to suggest solutions to us, it cannot formulate precepts. Elaborating the principles of law is for man to undertake.

A juridical machine can thus only be an aid to the jurist and not a substitute for him.

We shall have no "electronic judges" in the world to come, any more than we shall have a machine to rule us.

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DISCUSSION ON THE PAPER BY DR. L. MEHL

PROF. Y. BAR-HILLEL: I am sorry that I missed Dr. Mehl's oral presentation and I shall now make my comments on his preprinted paper. I hope there was no strong divergencies between the material presented on these two occasions.

First, I would like to draw a still sharper distinction than Dr. Mehl did between the two types of information-providing systems; the one whose output is a list of documents, a set of abstracts, a set of documents, or anything that stands in a one-to-one relationship to them, and the other that provides a sequence of statements as an answer to a question. Not only is Dr. Mehl's distinction not drawn sharply enough but he also believes that these two systems show a close relationship to each other. I do not think so. For the last three years, I have tried to impress people with the fact that these two systems are quite differently organized and that there exist no a priori reasons to believe that they have anything of importance in common. *(ref.1)* To my knowledge, there exists in England no mechanized system of any generality that provides answer to questions. Attempts to create such systems have been made in the United States, and perhaps also elsewhere, but I know of none that were really successful.

The two types of information-providing systems have so often not been told apart or, even when their differences were recognized, were regarded as having a closely related structure, as with Dr. Mehl. One reason is that the usual procedure of getting an answer to a factual question (of which no one in the neighbourhood remembers the answer by heart) is to first determine one or more documents (reference books, catalogues, research papers, etc.) that have a good chance of containing the answer and then to scan through these documents - preferably with the help of an index - in order to find the answer. The *first* stage of this two-stage procedure of providing answers is then indeed identical with the *only* stage of the provision of a reference list of documents that are (presumably) relevant to some research problem. However, jumping from this obvious fact to the conclusion that therefore a mechanized one-stage answer-providing system must be structurally similar to a one-stage reference-providing system is a clear *non sequitur*.

In the customary two-stage answer-providing system, the first stage can be mechanized to a certain extent, as I mentioned in my symposium paper as can, of course, the structurally identical only stage of the reference-

Ref.1 on page 787.

providing system. I tried to show there that there is no serious chance of mechanizing the second stage. Total mechanization of an answer-providing system is therefore incomparably more difficult than the mechanization of a reference-providing system. It is not just a historical accident then that hardly anyone has so far tried to develop mechanized answer-providing systems and that those who have tried did not get very far. Dr. Mehl gives some indication how such systems could be developed, but his indications are surely not explicit enough to tell how one should really do it.

I personally do not think that you will see any serious developments in this direction in the near future. For some very restricted fields one could probably do something, though not very much, because the answer to a specific question will in general not just be stored in the memory; most of the time you will have to deduce it from what is stored, and unfortunately machines that are able to deduce are hardly in existence so far. The logic which Dr. Mehl is mentioning in his paper, namely propositional calculus or Boolean algebra, is only a very small part of the logic which is needed for real deduction. There is no indication that Dr. Mehl is aware of this simple fact.

In addition, in order to serve as a medium of deduction, ordinary languages would have to be normalized, a problem which Dr. Mehl realizes without seeing through all its formidableness. No serious attempts exist so far to provide such a normalization for any field of appreciable extent. If Dr. Mehl believes that this can be done in the foreseeable future, I would want to most strongly insist that there exist no justification for this belief. The problem of transforming ordinary language into a formalised language system whose underlying logic is at least an applied first-order functional calculus, has hardly been scratched so far, and nothing indicates that the enormous problems involved are on the verge of being solved. (The only relevant study of which I am aware is a report by Miss Thyllis Williams).

Let me also remind you of a fact well known to logicians that for language systems of the kind mentioned there exists no mechanical method to tell whether a certain sentence does or does not follow from a certain class of other sentences, though such a method exists, of course, for a system whose underlying logic is the propositional calculus. But then, as said above, such systems would be totally inadequate.

The examples worked out by Dr. Mehl in connection with this problem ingenious though they are, show the difficulties rather than a possible way out. If you go carefully through all the intricate symbolism, you will notice that the argument is totally *ad hoc*. No indication at all is given how one could derive, from this example, any generalisation of how to treat a similar subject. Similar examples are treated in first-year courses in in logic. But surely there exists no unique way, or rather no way at all, for generalizing from such examples. So altogether, I am afraid that the hopes that information retrieval systems combined with logical deduction machines could be of help in solving problems in legal science are very premature, to put it very mildly.

MR. R. BENJAMIN: Prof. Bar-Hillel had to apologise that he had read the paper but not heard the lecture. I am afraid I have got to make the reverse apology; I have heard the talk but I have had no opportunity to read the paper.

Dr. Mehl points out that an essential preliminary to any mechanised literature search, in this field, is a rationalisation of the literature filing and indexing system, and that this rationalisation will be a major help by itself, whether or not mechanisation follows it. Referring to the possibilities of using electronic computers in the interpretation or possibly also in the drafting of legal documents, I feel the same problem would arise, and it would be a very severe one. From my *very* limited knowledge, it appears that legal documents use as few individual statements or sentences as possible, and make those as long and involved as possible. Computer language requires a very large number of very simple and concise statements; thus there is a very large problem in translating between these two languages. Indeed to a layman the rationalisation involved in putting some of the legal documents into the form of simple statements suitable for a computer, might be a very big help in itself - as well as being a formidable task.

MR. E. A. NEWMAN: I would suggest that, in certain respects, Prof. Bar-Hillel's criticisms of Dr. Mehl's paper are fallacious. Information retrieval is a subtle subject, and I shall attempt to make my point by use of an analogy. For my purpose there is sufficient analogy between solving a legal problem - or any other problem for that matter - and solving a generalised jig-saw.

Assume a store, containing all the pieces of every jig-saw puzzle that ever was. Assume that starting with one piece we have to make a complete picture.

What we would like is to find a label in the piece we have, in the form of a route instruction to get us to a store location which would prove to have just the remaining parts of our picture - and these already fitted together. The next best thing to this is for the piece we have to lead us to one piece that fits to it, and in turn leads to another piece, and so on. We are very much worse off if the clue on the jig-saw piece we have leads us to a location containing just the remaining pieces of the puzzle as a random arrangement, for then we have the difficult task of finding in what order the bits fit together. If besides the jig-saw pieces we need, the store location contains pieces of many other jig-saws all mixed up - then we have a collosal task ahead.

The purpose of a library retrieval system is to find for us the information - the jig-saw pieces - we need, correctly ordered and marshalled. The jig-saw piece we have is often just a set of impulses in our central nervous system - which make us speak, or move, or make suitable noises. The resulting speech movements or noises should lead us directly to a store location containing just the information we require suitably marshalled. Nothing short of this is entirely adequate.

To achieve this the storage system must contain a parcel of correctly marshalled information for every problem we are ever going to wish to solve - to forecast these requirements is truly a Herculean task. Each parcel must be in a separate store location so organised within the store that the clue in our mind leads directly to it. In other words the information retrieval system has to fit all the problems we wish to solve, and the way we are going to ask for the information. Given foreknowledge this could be done. No store location would contain a book, but rather the relevant information extracted from many books.

In practice we use a common language coding system that takes us to several books and within the books use a common language index system to take us to items. We converse with a librarian - who to some extent knows what is in his books - and with his help convert our question into one that fits the system. But one thing is sure; to be of any use the coding systems we adopt must be related in some way to the problems we wish to solve, and the form our questions will take. When Prof. Bar-Hillel suggests that the indexing system one uses is quite different and unrelated to the question one asks - that is nonsense; in so far as it is so the index system is no good.

Further, as Dr. Mehl says, because in legal matters it is possible to some degree to anticipate the problems to be solved, and the form questions will take - to that degree it is possible to make a good index system - and in so far as it will relieve the librarian of some question matching - thus far the retrieval system can be automatic.

MR. J. W. FREEBODY: I think there must be something fallacious in Mr. Newman's own argument because if his hypothesis is true how is it possible for one to solve the type of problem which requires some originality of thought for its solution?

DR. I. C. PRICE (written contribution): This is a most interesting and clearly written paper. The development of techniques for searching for items of information and combining them logically would seem to have applications to much wider fields than law: for instance, scientific literature searching, literary and textual criticism, and the mechanisation of office administration.

The use of large computing machines for legal purposes raises a number of interesting questions. If in a modern society the statutes, regulations, by-laws and legal precedents have become such a tangle that large computers are now required to deal adequately with regular legal business, the appropriate cure would appear to be common sense and self-control in the legislature rather than computers in the judiciary. But the use of formal logic in clarifying legal concepts and detecting inconsistencies is another matter. It could be argued that the desirability of avoiding ambiguities and inconsistencies, whether in new statutes or in case law, is such that formal logic ought to be used wherever practicable: and it may well be that the complication of the problem of applying formal logic to real legal problems would be such as to require the use of computers.

One field which might be used for a "pilot" investigation is the detection of inconsistencies in the rules of an association. This task would have two advantages, in that the field of concepts used is much narrower than that in the common law, and the law is already codified. The task of detecting inconsistencies in association rules is not entirely a trivial one: flaws are sometimes discovered in complicated rules, even when great care has been taken in drawing the rules up. An example occurred in the election rules of the Cambridge Union in 1956.

When the technique which the author has applied to his "tax" example is applied to a practical situation that might arise in the application of the rules of a society, one limitation shows up very seriously. This is the size of the storage required to describe a situation with n concepts. The storage of the description of each situation requires 2^n bits. Quite a simple problem can involve 30 concepts, which means that each storage location in the legal machine would contain about 10^9 bits, which is about 10^4 times larger than the whole immediate access store of a large modern electronic computer. So I doubt if the author's method of reducing legal argument to Boolean arithmetic will ever be used in practice. It might be better, though more difficult, to dry to develop a method of mechanical reasoning using Boolean algebra rather than Boolean arithmetic.

DR. L. MEHL (in reply): In spite of the precautions I hoped I had taken in my paper and speech, I find that my designs of juridical machines give rise to serious objections. However, I thought I had been prudent in my statements. It seems I was not. But now, I cannot go back and my duty is to face all the questions arising out of my ambitious designs!

The first question, examined by Prof. Bar-Hillel, is the distinction between the information retrieval machine and the machine for legal arguments: I persist in thinking there is no difference in a sense, because the second machine, the machine for legal arguments, has not the pretension to create information. This machine only transforms the data according to logical rules. Of course, the analysis of the concepts and of the relations between them is more complicated in the second machine and more precise, but I do not believe there is really any essential difference between this machine and the one for information retrieval.

Indeed, this statement is not universally valid. But it is true in the area of legal problems, because the solution of these problems consists generally in finding a similar case foreseen by the written law or stated by a precedent award. In these conditions, it is possible, in legal matters, as Mr. Newman said, to anticipate, in a great number of situations, the problem to be solved. If the case is not expressedly foreseen, then the machine can only help the jurist find the solution; but it is unable to give it. I insisted on that point in my paper. In other words, as Mr. Freebody noticed, the machine is not able to solve a type of problem which requires some originality of thought for its solution. It is quite obvious also that, although the machine is, in principle, suited to conduct legal argument, it is incapable of evaluating facts.

May I add, with great respect to Prof. Bar-Hillel, that I am aware that Boolean algebra is only a part of the logic needed for real deduction. I know that logical problems are not all mechanizable, at least in the present state of our knowledge. This question was especially studied by Markow, Novikow (indecidability in group theory) and more recently by Jean Porte, (France, C.N.R.S.).

But it seems reasonable to begin with the simpler questions where Boolean algebra is available. I question also the affirmation that my example is totally *ad hoc*. The same system of formulation may be efficiently applied to other questions. Concerning generalisation of the system, I explained for example how a complex concept can be reduced to a system of conjunctions and disjunctions of binary concepts. The system here proposed is applied to turnover taxes, but it is also available for all taxes, and I examined also the questions of income-tax.

The system requires transformation of ordinary language into a formalized language, a formidable task said Prof. Bar-Hillel and Mr. Benjamin. Certainly it is, if we formalize the whole human language. But here the purpose is rationalizing juridical language, that is to say a technical language, and to divide the difficulties. I propose to begin with tax terminology (because tax law is very precise).

There is still an important problem concerning the storage of information, as Dr. I. C. Price explained in his interesting written contribution. He points out that, even with a reduced number of basic concepts, each storage location would contain a number of bits which can be a hundred times larger than the whole immediate access store of a modern computer.

Dr. Price suggests the use of Boolean algebra rather than Boolean arithmetic; I agree with him. I explained also in my paper that it would be advantageous - I might have said necessary - to divide the field of concepts into separate independent groups in order to lead to simplification of the machine communication network and to eliminate meaningless combinations.

May I conclude by expressing some surprise concerning some of the objections that have been made. There are numerous attempts and designs, and some realisations in mechanical information retrieval (for example in scientific literature, in patent office, etc.) The only originality of my paper, concerning the first machine, is to try facilitating information retrieval in the legal sphere by the same processes. If I feared anything, in presenting my paper, it was being trivial, and stating the obvious. As to the second machine, I agree with Prof. Bar-Hillel that it is not a prospect for the immediate future. But that is true only if we are thinking of a machine able to treat all juridical questions; in a narrow sector of juridical questions, it is possible to build such a machine, and particularly for tax questions, because tax questions are a very logical part of law, and in fact, such a machine, in a restricted meaning now exists. I gave in my paper the example of automatic invoicing. It is possible - and I believe the system exists in fact in certain companies - it is possible, when the invoice is automatically made, to include also the automatic calculations of turnover taxes, for example. The problem of knowing what is the rate for such and such a product, according to its nature, to its origin, to its destination, is a logical one, and computers are able to solve it.

I am, of course, conscious that the machine for legal argument which I propose is a very elementary one, but I think it is not a bad method to divide difficulties and to begin at the beginning.

I have tried to explain my thoughts in English: this is not very easy for me, so will you excuse me if I have not been very clear. Thank you.

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