Representation and Exchange of Knowledge
as a Basis of Information Processes, H.J. Dietschmann (ed.)

HOW TO KNOW WHAT IS KNOWN: DESIGNING CRUTCHES FOR COMMUNICATION

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Information is a change of somebody's knowledge. The problems of information science are those of transference of knowledge between those who want it and those who might have it, and vice versa. Information systems are devices for establishing communication. Crucial problems are those of adequate representation of knowledge and of "growing" appropriate communication networks. Some research and design strategies are demonstrated.

WHY TO KNOW?

Some people want to know something what they do not know. Why? There are several reasons. One is pure curiosity - which may be rooted in the subconscious suspicion that the unknown item might be somehow useful for some future situation they could encounter. Or: the missing item might help to balance some discrepancy in one's picture of the world (and thereby help to contribute to one's peace of mind), or to brighten some dark spot in one's picture of the world (and, therefore, again help to pacify one's mind). Or: They just LIKE to get new knowledge, without intent to USE it for immediate practical purposes (PURE, entertaining curiosity!).

Other people want to know because they have a problem: they do not know what to do next. And - whatever they do next - should be based on some knowledge of the state of the world, of the world as it ought to be, of the workings of the world and of the ways of manipulating the world (or, at least, some of its parts).

Those processes which lead to this change of somebody's knowledge are called INFORMATION. Information is an event resulting in the change of somebody's knowledge. It is not something "stored" in paper documents, or in RAM files, or the like - although ink blots on paper or holes in a punch card or phosphorescent patterns on a vacuum tube may - occasionally - trigger information.

Where and how to obtain this information?

There are several ways of trying to acquire desired knowledge:

- further thinking and contemplation might lead to the desired certitude;
- gathering first-hand evidence by inspection (observation, measuring, experimenting);
- asking somebody else who is suspected to know;
- asking somebody else whether he/she knows somebody who might know;
- trying to find an answer by browsing/scanning through/looking up "documented knowledge" - in libraries of books, or in computer based collections of 'document-like code';
- he/she might dare a - more or less 'educated' - guess.

Which of these channels is most appropriate in a particular situation is a most difficult question and a very important information problem of its own right.

Not infrequently, information happens to someone who has not asked for it.

(..... surprise, irritating findings, confusion, ...)

INFORMATION SCIENCE is out to help the information seekers. In order to help/cure others, one needs to know (and this is another knowledge/info. problem) what the "HELPEES" need to know. Do the HELPEES know what they need to know. If not, who else? The HELPER? Perhaps not - if he/she is honest. If not, how can the helping information scientist and information system designer find out?

Designing an information system for somebody else (usually even: a large number of unknown potential information seekers) requires information about the problems of those future (anonymous) "USERS". This task implies not more and not less than "breaking one's head on behalf of future unknown users with unknown problems".

A formidable task.

If information science/engineering does not recognize this task, it will have failed its self-proclaimed mission.

This task presents a number of considerable epistemological and logical problems - in comparison with which hardware and software considerations are almost trivial. The bottleneck is not so much the size and speed of computers or the efficiency of programming but the understanding of KNOWLEDGE AND REASONING. It is not a problem of software engineering but of information engineering - "infware" before software.

The main questions to be dealt with are:

- what is knowledge? Which kinds of knowledge should be distinguished? What is their logical status in the processes of reasoning associated with different kinds of problems?

- how is knowledge conveyed, "externalized" in order to preserve it through time or to transfer it to another person? COMMUNICATION is nothing but one mind's attempt to affect some other person's state of knowledge, i.e. to 'trigger information'.

- how is knowledge encoded appropriately in order to guarantee proper decoding?

- what are the weaknesses of natural intelligence? Where - if anywhere - can it be supported and how?

- how to identify an potential source of knowledge? How to describe the "content" of a brain, a library, a book? How to kno what is known? If anywhere, where is this knowledge to be found?

- which operations of reasoning can be modeled in a way that they can be "delegated" to an external algorithmic mechanism?

The theoretical core of the information sciences consists largely of the knowledge responding to these questions. Whatever can be PRACTICALLY accomplished, is limited by the state of their treatment. Fortunately: modest as they may be, there are some tools and methods to analyze and to describe problem solving behavior (Kunz & Rittel -77).

The epistemological position of the information sciences is further complicated by another fact: information science itself is an information process; therefore it becomes a part of those processes it is out to study, to support, to design. The classical separation between the researcher and his/her object is not tenable. The consequence is the loss of neutrality and immunitity which the "normal" scientist or technologist appreciates so much. The information scientist becomes just another agent in the field of numerous, frequently controversial interests. He/she is a party in this field who wants to know "in order to .." - intending to bring about changes that affect others who, of course, react to this endeavour: Knowledge is power. (Kunz & Rittel -72)

This situation has methodological implications. It requires a very symmetrical relationship between the HELPER and the HELPEE. They become allies - possibly and usually AGAINST others. The ethical implications are obvious.

The information scientists' toolbox consists largely of communication aids - frequently labeled as "systems research", "user analysis", consequence assessment aids, organizational tools, etc. - exactly the same kind of merchandise they intend to sell to their customers.

NI VS. AI

A pair of glasses is meant to enhance somebody's eyesight. An automobil enhances somebody's mobility. The glasses do not see instead of you, or on your behalf. Neither does the automobil relieve you from travelling. They are "prosthetic" devices which support, reinforce, enhance some capacity or activity.

In the same way, information systems are prosthetic aids - devices to support activities of the 'unarmed mind'. With other words, they are nothing but crutches for the intelligent mind. They are no SUBSTITUTES for NATURAL INTELLIGENCE (NI) but enhancers.

Much of those activities under the heading of ARTIFICIAL INTELLIGENCE are motivated by a different ambition. They aim at MIMICKING intelligent behavior; their ideal is to design a machine that might even surpass the capacities of NI (like a chess player that beats the world champion). Devices of this kind are SUBSTITUTES and not prosthetic. Occasionally, one can hear or read statements like "Some day the computer will even be able to find its own problems", or "Once we have understood the working of the brain we will be able to design a better one". With other words: this is the ambition to construct the GOLEM, the synthetic homunculus, indicative of the blasphemic desire "to outcreate creation". Many a project of designing so-called expert systems of 'heuristic problem' solvers indicate this attitude.

Of course: a real homunculus should be able to exert judgment, TO JUDGE LIKE (or: on behalf of) A HUMAN - perhaps like the right, objective, neutral person. Unfortunately - or fortunately - this seems to be a real and fundamental barrier of what can EVER be delegated to a computer or any other 'algorithmic system'. What is good, desirable, relevant, and important defies - as a matter of principle - any attempt of finding an objective and definitive algorithm that mimicks those processes which produce human judgments. A little reflection reveals the reason: trying to 'found' one's judgment, to arrive at a judgment by deliberation rests ultimately and necessarily on 'offhand judgment', i.e. on judgments which are made 'off-the-cuff' and - therefore - are not justified or justifiable (by deliberation), and which therefore defy algorithmization (which is a prerequisite of computerization). In order to simulate a human problem solver, a program would have to take into account the totality of the human's experiences, knowledge, intentions which it is supposed to mimick.

Additional epistemological difficulty: trying to explore somebody's personal knowledge affects that person's personal knowledge. Therefore, what is to be mimicked is already changed by the attempt of mimicking it.

The number of fundamental obstacles against the GOLEM ideal can be extended - in particular, because the pursuit of this ideal is ridden by vicious circles and infinite regresses. Computers are doomed and stuck to algorithmic procedures - even if these are called 'heuristic'.

Looking at it more closely: who wants or NEEDS a GOLEM (for automatic indexing or translation, for finding THE OPTIMAL SOLUTION to a practical problem, for a RELEVANT PROBLEM IDENTIFIER)?

More promising, friendly and realistic seems to be a less ambiguous program than that ideal of AI. Instead of substituting for human intelligence, judgments, and emotions, let us try to enhance, to reinforce, to guide NI. It seems to be worthwhile to make it less probable that NI falls victim to its 'natural' weaknesses, such as the tendency not to perceive what is conflicting with one's pet ideas and prejudices, to reject irritating news, to neglect the search for long term consequences if the short term payoff promises some advantages, etc. etc.

Unfortunately, some crutches - and these are usually the good and comfortable ones - build up a dangerous temptation for their user. Since they are fun to use, or because they are very easy to use to a limited set of ends, or because taking trodden paths of thinking is the easiest, laziest, and - therefore - the most 'economic' way to get SOMEWHERE the user or operator of the crutch is tempted to let the crutch take its own way, its customary, easiest path. The more adaptive and the higher the "learning abilitiy" of the crutch, the greater the effort to retrain the helpful device and thus the inclination to be content with what the crutch can already easily do - instead of struggling with the crutch in order to make it help accomplish what one WANTS to do. In these cases, the crutches have changed into an automation. Oftentimes, the masters do not even realize this change, or - if realized at least subconsciously - the masters deny vehemently that this development is odd, irritating or consequential. On the contrary: There are many triumphant claims of successes of AI, i.e. of substituting NI by a synthetic device. And if there are some, shy objections, whether the NEW TECHNOLOGY might not lead to an oversimplification of the problems to be dealt with, or to the treatment of inadequate problems (just because they are so easy

to be dealt with!): If THE PROBLEMS DON'T LIVE UP TO THE METHOD - THE WORSE FOR THE PROBLEMS!

The recent history of the information sciences is full of examples for this effect. Information systems abound which are being used as YOUR FRIENDLY INTELLIGENCE SUBSTITUTES.

REINFORCING NI THROUGH INFORMATION SYSTEMS

What are the typical properties of a device which is apt to reinforce and to extend NI?

If we speak about a 'device' or a 'system' we do not mean a piece of hardware. It does not even have to contain much or any hardware at all. In any case, however, they are constructs of rules and procedures which are meant to serve the desired end. They may also incorporate hardware, such as books, telephones, mail-boxes, computers. In addition, there may be human operators who "man" the system (telephone operators, documentalists, mailmen, programmers, supervisors, repair-persons - who are faced with their own information problems).

The purpose of an IS is to reinforce some person's information, i.e. the change of his state of knowledge:

- by confirming what that person already knows, making him more certain;
- by adding to his knowledge;
- by weakening his knowledge, making him less certain;
- by deleting some item(s) of his knowledge, increasing ignorance.

Most information systems designed these days are of the first and/or second type. They are CONFIRMATION SYSTEMS. They are very likeable and popular because they reinforce the ego of their users and designers. Some information scientists would even go so far to claim that ALL information systems should be of this kind, that they should reduce uncertainty.

Nevertheless, the usefulness of confirmation systems is rather limited in view of NI-reinforcement. Information systems which - at least occasionally - stimulate surprise, trigger perplexity, shake up knowledge, tell what one does not expect or even does not like to know can be extremely useful NI-reinforcers. Doubt is the mother (father?) of invention. And reduced certainty leads to less careless plans and actions. Seeing what one would not see otherwise helps to take into account consequences of contemplated actions which would not have been taken into account otherwise. Being made aware of a flaw in one's pet idea reduces enthusiasm and may motivate the search for other ideas. Being informed about ignorance is a prerequisite for stimulating the search for new knowledge. Only exposure to the opposite view leads to fruitful reconsideration. Etc. etc.

In this context, it does not matter what the SOURCE of information is. It can be the result of immediate communication between persons. It can be the case of mediated and delayed communication through a document. And, most important, it can be communication between a person and him/herself: confrontation with my ideas of yesterday, becoming aware of inconsistencies, contradictions and fallacies, being reminded of what I would have forgotten otherwise, learning what one does not know (but should): the information system as a (somewhat alienated) 'mirror' of one's understanding. (Kunz & Rittel -70).

In many cases, it is not at all clear and unambiguous who is the USER and who the provider of the systems. Oftentimes (and these are the interesting cases) there is no clearcut demarcation between donors and recipients. Whoever wants to know 'through' the system is not unlikely to become a potential future provider.

Obviously, the NI-reinforcers need something to reinforce. The most powerful amplifier will not generate a measurable current from a zero input. And NI-reinforcers cannot turn stupidity into wisdom. Ideally, a lasting enhancement of NI results from intelligent use of intelligent NI-reinforcers.

SOME DESIGN PRINCIPLES

These considerations show that the "transfer of knowledge" is not a simple data-transportation procedure. Therefore, an information system which is meant to serve as an NI-reinforcer cannot be sufficiently described and designed as a "classical" data processing system (such as a police record file, or a bibliographical documentation system, or a computerized simulation model). It is rather a communication device which is subjected to a number of design principles.

P 1. Whenever possible, the system should establish direct communication between persons. In this role, the system becomes a referral device. It should grow networks of communication links between users which share similar problems.

P 2. Instead of trying to classify users and sources into clearcut conceptual categories, procedures of the kind "who knows somebody who might know somebody who ..." should be utilized.

P 3. It should not be attempted to "store" all knowledge ahead of time that might be useful. Whatever the system contains should grow with its use.

P 4. Whatever is "stored" and processed by non-human components of such a system are DATA, not knowledge or information.

P 5. Whenever communication is mediated by the system then a code is needed (a 'representation') which allows to formulate data which 'trigger' the appropriate knowledge in a recipient, with appropriate clarity and precision.

P 6. Whatever data are "contained" in the system should not be forced into a rigid hierarchical classification. Instead they should be linked by networks of relationships which correspond to the various types of similarity relations which guide associative processes. Ideally, the system grows "externalized extensions of the user's associative repertory" (Kunz & Rittel -77)

P 7. The system should keep a log of its use. In particular, it should keep a record of the problems in connection with which it has been used. The search for previous, similar problems and answers may lead to hints for treating a present problem.

P 8. The system cannot be better than its designer's knowledge of the structure of the knowledge to be dealt with and its dynamics.

Here lies the central task of information science: to develop methods for exploring its users' knowledge and their modes of reasoning, i.e. the systems analysis of the logic of problem solving and information. These are prerequisites for a "theory of mental crutches" and the design of better mental crutches, say, NI-reinforcing information systems.

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FROM THE STEREOTYPE APPROACH OF KNOWLEDGE REPRESENTATION TO A POLYMORHOUS CONCEPT OF KNOWLEDGE ORGANIZATION

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Based on empirical analysis of knowledge-oriented queries of various kinds (real life situations), the different forms and kinds of knowledge-types needed in particular problem-situations, are identified.

The findings drawn from the empirical material will be interpreted in terms of the idea of stereotypes in knowledge representation, in order to demonstrate in which problematic situations stereotypes may form an adequate knowledge base for response generation.

Finally, some examples of knowledge representation (based on the stereotype approach) will be given and possible limits of this approach will be discussed.

THE STEREOTYPE APPROACH AS A WORKING CONCEPT

DIFFERENT ASPECTS OF THE STEREOTYPE CONCEPT

In our recent work on knowledge representation and organization we used the stereotype approach first and foremost as a label for or path through different problem levels of the knowledge representation field. In this way "the pictures in our head", as Lippmann described the meaning or stereotypes so charmingly, were rather vague and only to some extent in agreement with the concept of stereotype as treated in Social and Cognitive Psychology, or in Psychiatry, which was one of the first disciplines to take over the "stereotypie" concept for investigations on patterns of behaviour, and finally, in Artificial Intelligence.