

Relationship between Elements of Knowledge (1972)  
(overview at: <http://www.laetusinpraesens.org/docs70s/elemknow.php>)

Appendix F: Future possibilities

Future prospects: an ideal knowledge-representation system: Appendix F1

Contents extensively incorporated subsequently into:  
Knowledge-Representation in a Computer-Supported Environment  
(Originally published in International Classification. 4, 1977, No.2, p. 76 - 81)  
(see <http://www.laetusinpraesens.org/docs/knowrep.php>)

Future prospects: an ideal knowledge-representation system

The ideal "information" system in a given academic field has been sketched out as follows by the U.S. National Academy of Science Committee on Information in the Behavioural Sciences under the chairmanship of David Easton. The ideal is here portrayed (\*) as a "computer analogue of the available, intelligent, and informed colleague."

"Such an ideal colleague would read widely, have total recall, evaluate what he read; he would be able to reorganize materials, recognize fruitful analogies, and synthesize new ideas. In addition the ideal colleague would always be accessible and available to all, either in person or by phone. Finally, such a colleague would be sensitive to each research worker's needs. He would be aware of the general interests and current problems of each scientist, and he could adapt both the context and style of his communication to each researcher's knowledge, skills, and habits." (\*\*)

There have been many reports on the improvement and integration of information systems and it would be futile and inappropriate to comment on them here. There seems, however, to have been little mention of what might be termed a "knowledge-representation" system (\*\*\*). The ideal colleague above would be the key component in a knowledge-representation system -- he would, it is suggested, have no place in an "information" or "documentation" system as they are currently conceived. This Appendix attempts to clarify the distinction between the knowledge-oriented and document-oriented approaches to system design by comparing the functioning of a hypothetical knowledge-oriented system, now technically feasible, with the current approach. The intention is not to imply that the former should replace the latter but rather that the former offers various means of avoiding some of the key problems faced by the latter -- the two are however complementary. The distinction is basically between a synthesis or atomisation in

(\*) Cited in the preface to: L. Larry Leonard (Chairman). Report and recommendations toward an international studies integrated information system. International Studies Association, Committee on Bibliographical and Documentation Services, 1969.

(\*\*) David Easton (Chairman). Communication System and Resources in the Behavioural Sciences; by the Committee on Information in the Behavioural Sciences, Division of Behavioural Sciences of the National Research Council, Washington, DC, National Academy of Sciences, (Pub.1575), 1967, p.46.

(\*\*\*) "Knowledge-representation could be considered to mean "information", but there are so many other interpretations of the latter that the new term seems appropriate here.

the handling of information as noted by J.M. Ziman:

"I cannot emphasize too strongly the importance of this activity of intellectual synthesis... Any notion that we may have about the nature of science includes the belief that something like an overall pattern is to be discovered and described. What we need is scientific knowledge -- not more and more miscellaneous and unrelated information. The starting point for a search should not have to be an abstract journal or a computerized retrieval system -- it should be an encyclopaedic treatise or textbook where the information has been transformed into an intelligible pattern of thought...from which can be deduced the characterization of the particular datum, specimen or phenomenon that we are studying." (\*)

The comparison is done in parallel column for ease of understanding.

(\*) J.M. Ziman. "Information, communication, knowledge." Nature, 224, 25 Oct 1969, p.323

Information

1. Index tends to be based on simple hierarchy or alphabetic listing of subject, author and title, which can be handled on catalogue cards.
2. Users want documents; the index is a temporary inconvenience to gain access to the document.
3. Author has "published" when document is in circulation and "available"; index entries of little significance to author.
4. Research is conducted primarily using documents as a stimulus to creativity.
5. Access to knowledge via documents, means multiple reproduction and transfer of documents to a variety of libraries where they may or may not be used.
6. Documentation system is embarrassed when faced with obtaining "ephemeral" or "phantom" material which has not been made commercially available through the few standard channels.
7. Out-of-date, rejected, low quality, false, old documents are retained in the system and index with no index indication to that effect.

Knowledge-representation

1. "Index" constitutes a complex network giving a representation of entities and relationships and the dynamics of any points under debate which can only be handled by multi-dimensional computer programming techniques.
2. Users want access to the "network index" which represents the items of knowledge and their relationships which they need; documents are a temporary inconvenience if it is necessary to re-examine data and detailed arguments justifying the entities and relationships incorporated. Document access is a secondary problem for which a documentation system may be used.
3. Author has "published" when the appropriate knowledge structure in the "index" has been modified; incorporation in "index" (through a terminal) is a high priority for the author.
4. Research is conducted primarily using the knowledge-representation structure as a stimulus to creativity, i.e., on the graphical representation.
5. Access to knowledge is direct and does not require reproduction and transfer of documents. (Only one copy of the document justifying the amendment need exist on microfiche so that copies need only be prepared when the data and arguments must be re-examined in detail.)
6. See 5.
7. Out-of-date, rejected, false etc. entities or relationships are eliminated from the system by listing them on paper (or other "documents") with the bibliographical source from which they were obtained (i.e. they are available if required but do not clog the system).

8. Only the knowledge held in the documents physically available is accessible. The index only notes the documents held in the documentation centre in question.
9. Thinking momentum is constantly interrupted when access to new documents is required. (Long delays, 2-3 months, are normal; 50 months or more from initiation of research to appearance in abstracts)
10. Authors status, pride and interest associated with visible document on some library shelves.
11. Author's domain of interest and home "territory" are unclearly defined.
12. The key figures in a discipline and the relationship between their spheres of influence are unclear.
13. Alternative concepts or contradictory evidence can be conveniently ignored in a document or textbook without too much risk -- particularly where the counter argument comes from another discipline (or a school of thought publishing in a different language).
14. Interdisciplinary links are ignored if the author has no interest in them.
15. Documents carry a lot of text which is verbal packaging for the main points, or didactic in intent, used to honour the elders of the profession, or provided in order to define the frame of discourse. Much of it is repeated in other documents on the same point.
8. All knowledge is on-line, although the supporting documents may not be physically accessible
9. Thinking momentum is maintained since the essence of any new domains of knowledge is always accessible -- all the links and entities are there (Delays are measured in seconds).
10. Author's status, pride and interest are associated with the visible entities and links in the graph representation accessible to all.
11. Author's domain of interest and home "territory" are visibly defined.
12. The "luminaries" in a particular discipline are all visible together with the relationship between their spheres of influence.
13. Alternative concepts, relationships or contradicting evidence is immediately forced on one's attention -- even in the case of relationships linking to other disciplines.
14. Interdisciplinary links are already held in position whether the author wants to ignore them or not.
15. Non-essential material is unnecessary because the points are in many cases already embedded in the knowledge-representation system. Arguments can be directed specifically to the use and relationships between particular entities. Such compacted arguments might also be directly accessible on call -- but only as a clarifying presentation.

16. Any panoramic summary of knowledge in a discipline -- the standard textbook-- must remasticate all the extant views which are visibly significant from the author's perspective. The author must "redo" the whole discipline environment to provide the framework for any new contributions of his own. There is no guarantee that the rephrasing (necessary for status and copyright reasons) of other people's arguments will make them any clearer. One result is to add a large wad of duplicate material to the documentation system, often of doubtful literary quality.
17. The documentation system does not permit of any permanent representation of knowledge in a particular domain. Each verbal summary extant at a particular moment is under criticism and subject to reserve from different schools of thought within the discipline. In this important respect a document arising from a single group of authors can never contain the totality of views in a domain of knowledge. It is only the non-concretized interaction between a succession of documents which approximates to it. These invisible qualifiers on any document are a feature of the "collective mentality" of the members of the discipline. The knowledge of the discipline at any moment is very much in (and between) the hands of its members rather than on paper or in a row of books.
16. The panoramic view of the entities and relationships in the discipline is always available and up to date. The author's extra contribution is all that needs to be added - he does not need to recap the whole environment. Since the academic's status is bound up with his specific modifications to the knowledge structure and not the verbalizations held in a document, the problem of adequate verbalization may be handled separately; Hopefully a limited number of skilled verbal presentations, from a minimum number of different perspectives and literary styles, could be constantly updated by professional writers using the best verbal arguments by any appropriate academics where appropriate.
17. Each entity, link, and qualification is indicated in the knowledge representation system. In effect one "layer" of the "collective mentality" of a discipline is rendered visible. Each modification to knowledge in the domain is entered on an hour-by-hour basis.

18. Different styles of documents are produced on the same topic for research, education, public information, program management, policy making, etc. purposes. The same material is repeated, with some extensions and some omissions, for each audience. But because it generally requires a person with a different style of thought to present each type of document, lags in the incorporation of the latest arguments or vital new evidence tend to be evident, so that there may be marked differences between the entities and relationships incorporated into each. This leads to a "spastic" or "aphasic" response to new situations, by different portions of society.
- No attempt is made in a document established for one purpose to relate the elements of knowledge to those of other purposes.
19. The documentation problem is aggravated by the "publish or perish" code which governs much of academic life. Unless an academic publishes, he is "invisible" --he loses status in the eyes of his superiors. A curriculum vitae is judged as much on the number of articles, books, etc., as on the quality.
20. Disciplines are psychosocial groups in which professional status and advances in knowledge are intimately related. At present intra-disciplinary communication is via documents for the knowledge advances, but the status and credibility of particular documents, and their authors are governed by ongoing informal word of mouth communication centered upon elders who set the fashions and designate ap-
18. The entities and relationships entered on the basis of research insights are also used for other purposes. Instead of producing different documents and reprocessing the insights, different "filters" are used in presenting or displaying the entities and relationships to different audiences. In this way, each new research insight is immediately incorporated into each other form of knowledge-representation -- each portion of society works from the same data base. (Problems registered by non-research bodies are immediately evident as a challenge to research.)
- In this way if an element of knowledge represented cannot be understood, the user merely calls for a new method of representation (of the same knowledge), possibly using isomorphs (or even analogies) from a domain with which he is familiar. At any point he can move into a programmed learning mode and work from simple representations.
19. By switching emphasis to the specific entities and relationships which the academic has formulated, successfully, confirmed or criticized -- his status is determined by the bonds and entities with which he is associated. Each of his contributions is "visible" until it is superseded and is not subject to the vagaries of the documentation system.
20. In the knowledge representation system, it is quite evident which issues are currently under debate and the manner in which the demise of a set of entities and relationships will entrain the fall of a whole set of dependent elements. It is also evident who are the key proponents or opponents -- directly or indirectly -- of particular knowledge elements. Ideally the knowledge representation system would also act as a continually updated voting board for each entity and relationship. Each addition to the structure

20.) proved new fashions. (and thus provide a needed element of stability). The procedure may be fairly democratic in that on each topic there are invisible collages of proponent and opposition "parties" in a "lower house", each with an eloquent voting constituency. The approval of the "upper house" of elders is required. It is by this ongoing formal-informal debating mechanism that the disciplines stance at any one time is determined. But the channels by which members of a discipline are exposed to new views and indicate or withdraw their support, are controlled, sometimes rather undemocratically, by well-placed elders. There is a tendency for new and contrary views to have difficulty in obtaining a hearing. This may slow the development of the discipline and make it somewhat dependent upon a form of intellectual nepotism and "smoke-filled club room" democracy.

21. Many academics subscribe to the building block approach to the advance of knowledge - particularly in the natural sciences (e.g. chemistry can be considered to be a skyscraper under construction, with 30 floors completed and in use, the 31st and 32nd under construction. Partitions in the lower floors are modified as required by new insights. In the more human sciences, the view might be that each academic constructs his own mansion inspired by the elements of the style of his neighbors and predecessors.) This is only a useful metaphor, however, since there are no recognized "building blocks"

(20.) of knowledge would cause some individuals in the profession to indicate a modification in their pattern of allegiance. At any one time it is then evident how much support a particular knowledge element can muster and exactly where the weak links in the chain of support are. The vague auras of influence which are symptomatic of the document-oriented system are replaced by a precise picture of the state of the game. Contrary views are represented on an exactly equal basis and are not subject to the vagaries of the journal referee system.

21. The "building blocks" are the entities and relationships added to the network which constitutes the "building". Any part of the network can be displayed as a visible representation of the "building" on which academics are working. This has the advantage of being a multidimensional dynamic structure in which any element can be questioned and modified without endangering the whole. The emphasis is on a community adding entities and links to a single existing visible whole, however many levels and domains it may be subdivided into -- individual initiative, whatever its domain, is related to that of the whole.

(21.) and no concretized "building" -- it also suffers from the severe disadvantage of constituting a "frozen pyramid" concept of knowledge categories. Each individual does his own thing with no attempt to relate it to the whole.

22. The forum of academic debate is concretized as a scattering of journals and other documents. There is little interaction between the journals but the debate is somewhat summarized in a scattering of abstracts in which the contents index gives some indication of the interventions on related topics.

22. The knowledge representation system constitutes a thinking forum in which the juxtaposition of relevant ideas from all sources is maximized. The researcher is exposed to a pattern of theoretical formulations in the process of being continually improved, and to which he can contribute. A dozen or more specialists in a particular field (the "invisible college" for that topic) cannot contribute simultaneously to ideas being written on one memo pad. They can do so via electronic dialogue support systems which help them to respond to each other's ideas (even if they are a continent apart) with a rapidity that allows each of them to maintain thinking momentum. Even in such a rapid debate the paternity of each emerging formulation is identified and registered. This mode of operation should be compared with some discussions between academics interested in the same topic in which progress is frustrated because if someone thinks of a good idea he wants to "publish" it (to gain credit) before contributing to the thinking momentum of his colleagues - this may take months.