Knowledge transfer: a key to successful application of knowledge-based systems

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Abstract

For successful application of knowledge-based systems, "knowledge transfer" (KT) should be receiving more attention. Knowledge transfer is defined as a flow of knowledge from knowledge suppliers through knowledge-based systems to users. Insufficient state-of-the-application of knowledge-based systems in Japan and its near future directions are analysed in terms of KT. Some example tasks for improving KT are reported. These tasks were experienced by the author in the course of 10 years of research and development on knowledge-based systems for project management.

1 Introduction

Technology transfer (TT) generally means the flow of new technologies from research to production, or research to practical application (see, for example, Bieber, 1969; Rothwell, 1978; and Boyle, 1986). Consequently, it may be quite natural (as Harris, 1984 and Kaplan, 1984, have done), to treat the transfer of artificial intelligence (AI) and knowledge technologies as a flow of these technologies from researchers (or AI tool suppliers), through vendors (or knowledge-based system developers), to users (or purchasers).

From a knowledge-based system user's point of view, however, the primary concern should be whether the knowledge-based systems can provide useful knowledge for efficient problem solving. The concern is not merely whether such systems contain new AI and knowledge technologies. Issues regarding how knowledge-based systems are emerging in practice should also be discussed from the user's point of view; that is, whether useful knowledge can be provided.

Therefore, the author stresses in this paper a flow of knowledge that runs from knowledge suppliers through knowledge-based systems to users. Such a flow of knowledge is referred to here as "knowledge transfer" (KT). The relation between TT and KT is shown in Figure 1. Two flows form a T-shape structure; TT flows from the bottom to the top, whereas KT flows from the left to the right. It should be noted that the researchers are distinguished from knowledge suppliers in that the former are exclusively AI researchers, whereas the latter provide knowledge and expertise from various fields. The dotted line represents the flow of needs feedback from users to both vendors and researchers.

2 State-of-the-application of knowledge-based systems in Japan

This section surveys the insufficient "state-of-the-application" of knowledge-based systems in Japan. It also describes the present situation, i.e., that the importance of KT has escaped the notice of people in virtually all categories of the knowledge flow shown in Figure 1.

- Most knowledge-based systems have remained at the demonstration or experimental systems level. Expected users do not request real knowledge from such systems. Thus, there is no-needs feedback regarding knowledge from users to vendors or researchers. As a result, systems vendors

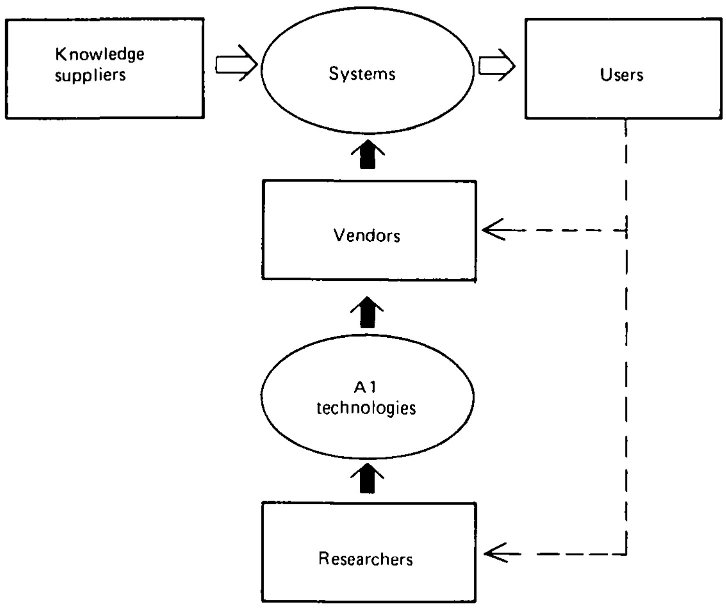

Figure 1 The relation between technology transfer and knowledge transfer: ➡ technology transfer; ⇨ knowledge transfer; --→ needs feedback.

or developers do not become aware of the importance of knowledge itself. Instead, they concentrate their efforts on developing tools that support easy implementation of "demonstration" systems.

- Some successful systems, although very few, have been developed by super-excellent researchers and developers who are experts in both AI technologies and domain knowledge. As a result, AI technologies and domain knowledge are so well incorporated into knowledge-based systems that users do not explicitly recognise the important role of knowledge. Rather, they are apt to think that the systems' good performance is due mainly to the technologies that the vendors apply. From their business point of view, this is what the vendors wish the users to understand.
- Knowledge-based system vendors are likely to be contacted by persons in the technical divisions (such as a data processing division) of client companies, who are concerned with the technological aspects. Knowledge content is not of interest to such persons. This leads the vendors to have little concern for knowledge.
- Purchasers (users) of knowledge-based systems are usually preoccupied with learning the systems' elemental structures and mechanisms before they try to apply them to their actual problems. Today's AI seminars for users in Japan are full of technical lessons, e.g., how to use UNIX, C, LISP, PROLOG, production systems, frame systems, and expert system tools. Users are dazzled by such technological items.
- Most mass-media and vendor advertisements say, "IF you buy tools, THEN you can automatically implement real knowledge-based systems". These advertisements rarely mention the necessity of mastering the hard tasks of knowledge acquisition.
- Artificial intelligence fever in the mass media makes the top executives of business firms very sensitive to AI. They want knowledge-based systems because of the rumours that say their competitors are introducing (not "using") such systems. In many cases, the purpose of buying such a system is not to use it, but to have it as a status symbol. Even if such systems are at the demonstration level (and not workable), this fact is seldom understood by users because these systems are not used for practical problem solving. Instead, they often merely remain "toys" of technical persons.

3 Near future directions

People will become aware of the importance of KT as they accumulate experiences (using trial and error) in applying knowledge-based systems to their actual problems. In Japan, this will happen in the near future for the following reasons:

- Users are ready to take the next step forward toward actual applications, because they have become disillusioned with demonstration systems.
- As the scope of application domains gets wider, there are a limited number of super-excellent developers that have high analytic ability with domain knowledge. Consequently, developers will have to ask knowledge suppliers or users for help in acquiring domain knowledge which explicitly informs the users of the central role of knowledge in knowledge-based systems.
- Most users will, in two or three years, graduate from AI technical seminars and read through AI text books. They will certainly request reports on actual knowledge-based systems implementation as a next seminar course. (Even today, some teachers have begun to incorporate such case studies in technical seminars.) As a result, users will come to understand that their main objective is to obtain knowledge, and that AI and knowledge technologies are the only means to attain this objective.
- In the very near future, the "AI dream" will no longer have news value for most mass media. Instead, they will report on the "AI reality", a reality that is full of failures of knowledge-based systems that overstress AI technologies and neglect knowledge content. Wise people will then learn the power of knowledge content, which will turn people's attention to KT.
- Many Japanese companies will not be able to afford to have "toy systems" only as status symbols, because of the encroaching severe economic environment. However, a few companies that really need knowledge-based systems for their problem solving will probably make their efforts to implement workable systems, and, doing so, they will gain an understanding of the central role that knowledge plays.

4 Sample tasks in knowledge transfer

Since 1976, the author has been doing research and development of knowledge-based systems for project risk management (Niwa, 1979, 1982, 1983, 1984, 1986, and 1988). The purpose of the system was originally described as follows.

> The dramatic changes in the world economic balance in the early 1970s have spawned many big construction projects in developing countries, especially in the Middle East. In the process of carrying out these projects, a great number of "risks", defined here as undesirable events such as troubles and accidents which cause delay of projects or excess expenditure, have been known to occur. This is due primarily to the dramatic escalation in the size and scope of projects and the contractor's lack of experience in these countries. Consequently, development of methods or tools to assist project managers in achieving more effective control over these risks have become an urgent task (Niwa, 1979).

The knowledge-based system's function was to provide project managers (users) with appropriate knowledge, gathered from many project managers and fused into the knowledge base. The system was designed basically to warn (in forward reasoning mode) the user of risks that could follow from causes specified by the user, as well as to confirm or deny (in backward reasoning mode) hypothetical risks based on its model of risk causes.

The author performed several tasks that seemed closely related to KT in the course of developing the knowledge-based system. Some of these tasks and their backgrounds were as follows.

1 The users wanted to retrieve knowledge (especially risk experience) from the knowledge base in a very easy way, in addition to using the common reasoning modes. In response to this request, a KWIC (KeyWord in Context) retrieve function was added to the system, and was significantly welcomed by the users.

2 The users wanted to be provided with supplementary (or raw) information, such as original risk reports (the summaries of which had been input into the knowledge base), original documents or drawings related to risks. Consequently, a "supplementary file" was implemented in addition to the knowledge base.
3 As the users became accustomed to the system, they began to voice complaints that the answers which the system provided were too predictable. This is because the system was limited in the extent of its logically related knowledge, the fundamental relations of which were determined at the time the knowledge base was implemented. The users wanted to be informed of knowledge from the knowledge base even for different contexts that could not have been expected at the time the knowledge base was implemented. A new sub-system was then added that guided the user's association ability, which helped the computer search the knowledge base for non-logically related knowledge (Niwa, 1986). By non-logically related knowledge, we mean that there are no inference or network chains connected to the knowledge in advance.
4 The most time-consuming and most difficult task was to acquire knowledge from many project managers. They were generally reluctant to offer knowledge obtained from their experience, partly because they were busy and partly because it seemed of no merit for them to offer their risk experiences (which included their failures). Our strategies to overcome this problem involved:

- Organizing a company-level committee, whose chairman was a top executive; this committee authorized project managers to spend person-hours offering their knowledge.
- Encouraging knowledge suppliers to be users. The method of doing this was to say, "If you offer five pieces of your knowledge, then you can obtain 495 pieces of knowledge from the knowledge base, because there are 100 knowledge suppliers and users".

The above first three functions, i.e., 1, 2 and 3, were originally requested, explicitly or implicitly, from the users after they actually used the system. This was the case even though it was thought the system requirement analysis had been carefully carried out by a small pilot system which had been developed for that purpose. In the knowledge-based system design phase, it was difficult for both the developer and the users to give much consideration to knowledge transfer aspects (e.g., what kinds of knowledge are really needed?). Instead, they gave most of their attention to technology transfer aspects (e.g., how AI technologies can be applied). The general reasons for this were described previously in this paper. In addition, the author would like to present one more reason the system developers were apt to concentrate on technology transfer aspects and not on knowledge transfer aspects: knowledge transfer aspects cannot always be handled by current AI technologies, and using old fashioned technolgies (not AI technologies) is not regarded in the AI professional circle as producing achievements. Actually, it was for this reason that the author did not write technical papers treating points 1 and 2, as they were solved using non-AI technologies.

The fourth task 4 is out of the scope of current AI technologies. Knowledge acquisition, in a narrow sense, is regarded as one of the most important AI technologies. However, in its wider sense, the importance of knowledge acquisition comes to the fore when real systems are implemented and maintained. In our experience, item 4 was the biggest problem that appeared during the system development process.

These sample tasks may give us a lesson: in order to implement successful or workable knowledge-based systems, developers should pay more attention to the KT aspects. Researchers should also establish research and development themes for KT.

5 Concluding remarks

This paper presented "knowledge transfer" (KT) as a key to the successful application of knowledge-based systems. In terms of KT, this paper surveyed the insufficient state-of-the-application of knowledge-based systems in Japan, as well as the present situation of people having overlooked the importance of KT. Researchers and developers should pay more attention to KT aspects so that knowledge-based systems may emerge in practice. This position may also be presented as a restatement of the view that we should go back to the starting point of knowledge engineering, i.e., "knowledge is power" (Feigenbaum, 1977; Lenat and Feigenbaum, 1987).

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