A BASIC PRINCIPLE FOR THE ARCHITECTURE OF COMPUTER-BASED INFORMATION PROCESSING

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Abstract

In this paper we discuss the effect of computer-based information processing on the adaptability of the systems. Because of the close relationship that exists between subsystem independence and adaptability, the effect that the structure of computer-based information processing has on the degree of independence between the subsystems of the system that makes use of computer-based information processing (referred to here also as the host system) is central to our discussion. We are focusing here on complex systems that are controlled and operated by humans with the help of computer-based information systems and that face an uncertain environment. This type of systems includes organizations, complex projects, and complex processes and devices controlled by humans with the help of computers. The view of information processing as an aspect of the dynamics of systems (Kampfner, 1998) is also central to our discussion. An important advantage of this view is that it allows us to study the relationship of information processing with other aspects of the dynamics in which it occurs. This in turn gives us the potential to understand the role that information processing plays in practically any particular kind of natural and artificial systems.

Three closely related, but distinct types of interdependence between the subsystems of a system can be distinguished. The first one is the interdependence between the computer-based information system, itself a subsystem of the system it supports (referred to here as the main system) and the other subsystems of the main system. The second type of interdependence is the one that exists among the other subsystems of the main system. The third type of interdependence is between the components of the computer-based information system. These three types of interdependence between the subsystems of a system are clearly closely interrelated. Each of these types of interdependence has characteristics that distinguish it from the other types. The first type of interdependence is characterized by the combination and the interaction of human and computer-based information processing.

At the core of these three types of interdependence is the role that computer-based information processing plays as an integral part of the processes that perform the functions of the host system. An important part of this role is to undertake part of the information processing aspect of these processes. In doing so, a computer-based information system becomes an integral part of the processes that it supports with information. The interdependence between the computer-based information system and the subsystems of the host system that it supports (the first type of interdependence)

stems from its role as a provider of information to the subsystems it supports with information. It is therefore inherent to the role that computer-based information processing plays in the processes that perform the functions that the subsystems involved represent.

Computer-based information processing affects the second type of interdependence in an indirect manner. Any change in the information processing aspect of the dynamics of a system has some effect on its structure and dynamics. Since the introduction of a computer-based information system changes the structure and dynamics of information processing in the host system and this ultimately results in a change in its overall structure and dynamics, it is obvious that it also affects the interdependence between the subsystems. A new, or modified, computer-based information system can reduce the second type of interdependence by taking up some of the informational interdependencies that the subsystems its supports have between them. The reason is that by exchanging with the subsystems it supports information that otherwise would be exchanged directly between these subsystems makes them less dependent on each other. However, it should be noticed that, for the same reason, every reduction of the interdependence between the subsystems that the computer-based information system supports results in an increase of the interdependence between these subsystems and the computer-based information system.

The third type of interdependence occurs between the processes that the computer-based information system provides. The structure of computer-based information processing affects this type of interdependence because it entails a particular set of relationships between the components of the computer-based system such as the pattern of distribution of computer-based information processing, the type of interaction that exists between the components of the computer-based system, and other types of interdependencies between components that the structure of the computer-based system imposes. The structure of computer-based information-processing also affects the other two types of interdependence. It does so because it participates in the influence that the overall structure of the host system has on all the aspects of the dynamics of such a host system. The structure of computer-based information processing contributes to the overall influence that the structure of the host system has on the overall dynamics through the influence it has on its own dynamics (i.e. the way in which the computer processes proceed), on the dynamics of human information processing (i.e. the way in which humans process information in the host system), and on all the other aspects of dynamics of the host system including those that do not deal with information processing.

Our emphasis on the effect of the architecture of computer-based information processing on the adaptability of systems responds to the fact that the structure of any system influences its dynamics and its adaptability. Just as information processing is an integral part of the dynamics in which it participates, the architecture of computer-based information processing is an integral part of the structure of the host system. As such it partakes in the influence that the structure of the host system has in its own dynamics including the information processing aspect of this dynamics. As part of the structure of

the host system, the architecture of computer-based information processing influences the dynamics and adaptability of the host system and, consequently, its own dynamics and adaptability. Focusing on the architecture of computer-based information processing thus helps us investigate its contribution to both, the dynamics and adaptability of computer-based information processing itself, and the dynamics and adaptability of the host system. These two types of contribution of computer-based information processing to adaptability are closely interrelated and involve tradeoffs that, as explained below, the designers of computer-based information systems must handle properly if these systems are to contribute effectively to the adaptability of their host systems.

Clearly, an important goal of the designers of effective computer-based systems is to design an architecture of computer-based information processing that enhances the power of human information processing while preserving or enhancing the ability of the host system to cope with the uncertainty of its environment. Some relevant features of this architecture and its relationship to subsystem independence and adaptability are discussed in this paper.

REFERENCES

Kampfner, R. "Dynamics and Information Processing in Adaptive Systems," *BioSystems,* Vol. 46, pp. 153-162, 1998.