Executive Workstations – Information Delivery for Executives

Kirk M. Jones  Dave King
Executcom Systems Corporation

Abstract

Executive workstations are high performance computer-based systems designed to assist executives in dealing with massive amounts of data. The goal of these systems is to assist the executive in the performance of relative routine, but complex tasks in order to free time for more demanding and rewarding work. The systems embody state of the art hardware and software in order to accomplish these tasks. This paper examines some of the requisite features and attending benefits of this new class of computer technology.

Introduction

Executive Workstations (EWS) are another step in the evolutionary development of systems that convert data into information. They are in the evolutionary path because they rely on the successes (and failures) of previous systems for some portion of their functional content, and for an even larger portion of their philosophical orientation. They are a new step because they add new and exciting functional capabilities and because they broaden the class of users who can effectively use the family of information processing tools.

The development of EWS places certain requirements on the hardware and operating system of the computing engine and on the user software component of the system. Briefly, the user of such systems is interested in accessing, browsing, and analyzing data in order to develop information to communicate to other individuals in the organization. The tools to accomplish these ends will now be examined.

Hardware/Operating System Requirements

The rapid changes in the capabilities of computer hardware are opening new possibilities for deliverers of end-user, computer-based systems. The time has gone when software designers must spend inordinate time designing their system to run in a limited memory space, or with limited processor speed. The result is that information processing techniques and algorithms that were economically infeasible just a few short years ago are now perfectly acceptable. EWS will take advantage of virtually every capability available on modern computational networks. In order for the workstation to fully realize its potential as a delivery vehicle, there are three major hardware capabilities that must be supported.

Network Capabilities

First, the workstation must be networked. This implies that the workstation is a part of the corporate information network and/or has immediate access to all types of external data. It also implies that the workstation exist on a network consisting of heterogeneous systems, each of which is capable of communicating information with all other machines, or a peer, i.e., any machine can request any other machine that it supply some item of data or perform a processing task. In addition, the fact that the hardware exists as a part of the corporate information network implies that the security and integrity constraints necessary for organizational effectiveness can be implemented and monitored.

Because the workstation is networked, it has access to information and programs residing on other computers. These may be geographically close or far, it does not matter. Because of other communication support, it is also possible for the workstation to access commercial data services and extract items such as stock quotes in a real time mode. EWS will support multiple, simultaneous sessions communicating with other computer systems so that the end user can access the data they need for the tasks they need to accomplish.

The attraction of this tight inter-connection of all the computational systems on the network is that user no longer cares which computer runs a particular job. The workstation makes the decision as to where a particular job should be run, as when a user exists, and then takes the appropriate action to resolve the difficulty. The EWS becomes the user’s window into the information processing world.

From the organization’s perspective, each computational device, whether mainframe, or mini, or workstation is effectively utilized to perform the task that it does best.

WIMP Interface

The WIMP (Windows, Icons, Menus, Pointing) interface has proven itself for a wide range of solution tools for computer based applications. In particular, it appears to be superior in situations that require the user to invent new methods in order to generate a solution [3]. Since a significant portion of the tasks associated with executive level managers require this level of innovation, the WIMP interface appears to be the primary choice for interaction style. In addition, the EWS is competing with sheets of paper in the information display arena, this interaction philosophy will be used for portraying system actions, functionality and information. The advantage of this interaction style is that it allows the display device of the system to mimic, if not surpass, the informational display characteristics of paper, while at the same time giving the user much more powerful ways of developing (electronic) documents for communicating with others in the organization.

Just like a desktop, the user is not restricted to one or two sheets of paper showing on the screen. Conceivably, an almost unrestricted number of "pages" could be put on the screen. However, just as we get confused when we have too much paper on our desk, we will get confused by too much clutter on the screen. EWS software can do much to assist in the clutter of the screen, like the good administrative assistant does for the desk.

Multi-tasking/Window Environments

It is difficult to separate the two major features of the operating system that will allow the executive workstation user to exploit the full potential of the system as an information processing center. There are multi-tasking and window-based environments for interacting with the computer. A multi-tasked operating system allows more than one task to be performed simultaneously by the computer. For years, mainframes and minicomputers have functioned as multi-tasked systems, although most users viewed them as single task machines because each user was able to interactively run only one process at a time. Window interface techniques transform a single display device with one view of the computer to a device with multiple views of the computer network, each having the capability of performing any task that any other view could perform.
functionality is equivalent to having several terminals (or personal computers) on your desk at once available to run the applications that you normally run. The differences that the window-based EWS gives is that no additional space is needed for the additional systems, and that it is possible to move information from one window to another at any time. In addition, there may be other applications processing in the background to perform tasks necessary to support the user's requests. user's requests, but mainframe or some other remote database.

Performance Characteristics

The final requirement for the workstation is that the processor speed is adequate to ensure that there are no delays in the response that are inconsistent with the difficulty of the task being performed. This rules out older generation personal computers, but it does encompass most of the traditional workstation class machines. A noteworthy point here is that for most users, it is not the absolute speed of the computer that is important (within reasonable bounds), but it is the predictability of the timing on a given task that is their prime consideration in effectiveness. With personal computers, timings were absolutely predictable, but slow. With time-shared mainframes and mini-computers, extreme variances in the response of the system were the norm, not the exception. Workstations, because of their unique blend of mainframe operating systems and personal computer availability offer predictable response times with much faster computations than traditional personal computers.

Another important point to note concerning the computational speed of the workstations involves the tasks which will be performed. Clearly, much of the difficulty in performing computer-based tasks has been related to operating system and application interfaces. Typically, these forced the user to remember the sequence of steps necessary to perform a specific chore. With workstations, many of the more mundane tasks will be done automatically by the EWS. In practice, the EWS will be expected to learn about what the user typically does, and to assist in the completion of these normal tasks. The methodologies for accomplishing this will provide constant feedback to the user relative to choices made, and relative to the consequences of potential choices. In fact, a significant portion of the computational resources of the computer will be devoted to performing these tasks for the end-user.

Functional Requirements

The software requirements for an executive workstation are somewhat harder to define than the hardware or operating system requirements; however, they embody the key value of the entire system. The lack of definition is not surprising in light of our inability to define exactly what a senior manager does. We know that a senior manager's job is characterized by fragmentation and diversity, and that senior managers themselves have a hard time describing what they do. On the other hand, most of us know effective management when we see it [9] (leadership, awareness of the organization, awareness of the individual, strategic orientation, etc.). These considerations lead us to the development of tools on the executive workstation that will save the manager 10 minutes here and there, make communications to peers and subordinates clearer and more effective, and make it possible for the executive to directly access the results of tasks normally associated with analysis and monitoring of ongoing results and plans.

Some of these areas are relatively well defined and understood, e.g. electronic mail applications and monitoring of critical success factors. Others touch the forefront of technology, e.g. the application of expert systems technology to allow the incorporation of some of key employee or executive expertise into the overall analytical processes of the system. A critical fact regarding the implementation of the tools is the recognition that, like DSS, these systems are supporting individuals in an organizational role. Therefore, they must not only consider the individual nature of human beings, but they must support the goals and ends of the organization.

One explicit recognition that a software system running on a workstation must make is that there are two major classes of users. The first class of users develop systems which will be used by others, and the second class primarily uses the results of applications, with only intermittent need to perform ad-hoc analysis or unexpected queries. In some cases, a single person will fill both roles; however, their needs will vary depending on which task they are performing. In the following, the various functionalities for each of class of users will be discussed. Since the end use of the system is the most important, it will be covered first.

User/Data Access

One of the universally recognized functions of executives is that of data gatherer. Traditionally, the sources of data have been peers, subordinates, and media. As the use of electronic means for the collection and dispersal of information becomes more pervasive, their reliance on electronic retrieval methods will become a regular part of their normal tasks. [1] One of the foundations for the entire concept of the EWS is the transparent access to data. At one extreme, this might be as simple as retrieving stock prices from a commercial data service on a daily or hourly basis. On the other hand, it might entail having a detailed description of the retrieval process to generate an on-line sales report based on the data distributed across several computers at various locations around the world. The retrieval processor would have the "intelligence" to access the data, combine it into an integrated picture, notify the executive at the time that the report became available, and in an ideal world, automatically develop a summary with points which should be attended to immediately. [10] The document would automatically be updated whenever the underlying data on which it was based changed.

User/Browser

Associated with the transparent access to data is a browsing functionality. This is designed to allow the executive, in an unstructured manner, to browse through multiple sources of data and to create as many views of the data as needed. It is through this process that the executive is allowed to exercise the creative powers of association, assimilation, and deduction that form new insights into the directions of the company, the industry, etc. In some cases, the browsing will provide structure in which to interpret new data, since it is the case that data without a context or environment can only be data, but
Once a context is known, the data is transformed into information. One of the newest technologies for the support of browsing is hypertext. [11] [7] An essential feature of hypertext systems is that they combine graphics and text into single documents, but in addition they allow for powerful interconnections between the pictures and words. With the hypertext systems, it is possible for the user to point at a word or symbol, and the system immediately displays additional information on that item. For example, suppose the user was viewing the results of a consolidated analysis of profit. An item such as selling expense could be pointed at and selected, and the underlying detail would be displayed, perhaps accompanied by an organizational chart depicting the structure of the consolidation. Additional selections could further detail the underlying reasons for the form of the result.

User/Monitoring

A related function of the EWS is to monitor results as they occur and to notify the executive of any significant deviation from what was expected. This implies that the workstation software is capable of understanding a definition of what is significant in addition to having the capability to locate and process the benchmark data and the actual results. For the near term, the process of “teaching” the system this information will be accomplished in a traditional manner in which a knowledge worker encodes the criteria, locates the data, and develops an expert system for performing the monitoring. [5] [12] Longer term (and more blue-sky) it should be possible for the executive to sit down at the EWS, look at results, notice an anomaly, and probe the system until a reason is found (possibly by talking, electronically, to other individuals). At that point the executive will be able to enter something equivalent to “If that ever happens again, let me know”, and the system will establish a new monitor for the manager.

User/Interface

One function of the EWS software is to provide to the user an integrated view of the capabilities of the system. The mechanism for doing this is the user interface of the system. More than any other aspect of the solution vehicle, the purpose of the interface is to communicate the state of the system, the states to which the user can move, and the actions that may be taken. [4] It is somewhat important to note that the interface itself does not provide the functionality. In a sense, this defines the interface as an enabling technology, not a solution technology, and it defines the criteria by which the interface should be evaluated: if it is transparent to the solution of the problem, then it is right; if the user sees the user interface (as interface), then it is wrong because it obscures the problem and its solution. This final criteria demands that the user be given some choices in the interface, because the diversity of human skills, backgrounds, and psychological preferences prohibi a single interface from being useful to all people, just as they prohibi a single interface from being applicable to all types of problems.

User/Mail and Documents

Because of the necessity for speed in communications, it will be necessary for the EWS user to have immediate and easy access to the corporate mail facility, and through it, access to various electronic mail facilities across the world. [1] Essentially, this access will allow the executive to access any functionality of the workstation, review its results, and then to create a document, with attachments that can then be sent to any other location in the world with equivalent mail facilities. These documents will be used both for audit trails for corporate accountability and to support the long-term memory of the organization itself. The electronic portion of the EWS will make the distribution of the formal documents easier and faster, although it will not completely replace the reliance of the organization on paper as a communications and memory media.

Builder Software Requirements

Although the user of an EWS is the focal point of the system, a discussion of the more technical aspects of the system is in order, primarily because a good portion of the costs of delivering such systems will be from the support side. It has certainly been the case with DSS that the initial cost of the software and hardware is insignificant in comparison with the people time of developing, maintaining, and modifying such systems. Thus, the following functionalities will be necessary (at a minimum) in order to make sure that EWS are worth the effort spent in their purchase and implementation.

Builder/Analysis Tools

Most problems whose solutions are of value to an organization are a blend of quantitative facts and assumptions, qualitative statements and assertions, and other factors which may be non-rational or intuitive. Certainly, DSS have proved that we have the ability to create models of organizations and problem situations that can assist in our understanding of the inter-relationships and ramifications of various quantitative aspects of problems. The current state of expert systems implementation shows that we can represent numerous qualitative aspects of problems in deductive or inductive based reasoning systems, and gain further insight into the ramifications of various problem structures.

It will be necessary to provide the builder/analyst with a full range of financial modeling capabilities in order for them to fully explore the computational needs of EWS. In addition, expert systems technology can be drawn upon to furnish the logic modeling facilities necessary for developing deductive, diagnostic, and monitor types of applications. [2] The combination of the two technologies will allow the user significant new capabilities in terms of asking what-if questions about both quantitative and qualitative problem information.

Builder/Extensibility

The concept of system extensibility is fundamental to a number of user-oriented, computer-based tools. At the surface level, this means nothing more than giving the user of the system the capability of solving new and unexpected problems with the tool itself. At a deeper level, it means incorporating into the system itself the capability to allow a user to package the results of a system in such a way as to make them available to another user also as a tool. Since we understand that the goal of the EWS is to push the solution more
and more into the hands of the people that have a stake in the problem (and in its resolution), the EWS software systems will have to give application developers methods for extending their systems, sometimes rather dynamically, to cover new and unexpected situations.

**Builder/System Tools**

The builder aspects of EWS software will draw heavily upon the technologies developed in Computer Aided Software Engineering (CASE) and upon the methodologies used in software development environments for artificial intelligence workstations. In both of these areas, the job of the applications developer has been simplified by placing more of the burden for housekeeping, administration, and code generation on the attendant support software. In addition, the two technologies have attempted to automate the normal processes by which individuals create, maintain, and use computer-based systems.

One way in which these technologies have done this is to take what is known as an object-oriented approach to systems development. In this methodology, a hierarchy of classes of entities are defined. Each level of the hierarchy has properties (attributes, or items of information) associated with it, as one progresses through the tree, the number of properties increases. Each class also has the ability to make a specific case, called an instance, of itself. The beauty of an instance is that it assigns specific values to all of the attribute properties of its defining class. This includes all attributes which are included in any class from which the class itself is specified. If the need to change an attribute in any super class arises, only a single definition need be changed. This property leads to systems with higher integrity and lower maintenance costs. [13] As an example, consider the process of building financial models with an object oriented approach. First, an abstract entity called a model could be defined. The model has the properties of having line items (variables) and time periods (columns). Next, a sub-class of model called an income statement is defined as a model whose variables have the properties of being expense items, revenue items, or derived items (ones dependent on the expenses and revenues according to some algebraic relationship). To create a specific income statement for A/B/C Corporation, the user would create the sub-class income statement with a specific set of data for A/B/C. All that is necessary to create a new type of model is to create a model subclass with new properties, such as asset, liability, and ratio variables. Definitions for derived variables could be distributed, based on the classes, thereby insuring consistency and integrity of both the data and the computations. If the system consists of a number of income statement instances (for differing operating entities), then a redefinition of the computation for an item such as 'Net Present Value' could be accomplished company wide with a single redefinition at the appropriate class level.

This particular paradigm is important because it truly reflects the way in which people develop new problem solutions; normally when faced with a new problem, most people make an analogy of the current situation with one that they have solved in the past. They then take the old solution and modify it until it fits the new situation, and they do this even if they must modify the entire original solution. The object oriented approach amplifies the normal process by making it more explicit, more maintainable, and by providing a better built-in audit trail for the solution process. In addition, it provides a vehicle for distributing the expertise of a problem solver throughout an organization. This in itself will result in better applications because everyone will have access to the methodologies utilized by experts in specific fields.

Properties may be used in the representation of data about the data in the system itself. Thus an EWS will allow the specification of knowledge about how the knowledge in the system can be used. This will allow builders to provide explanations as to model or data behavior in terms of computational algorithms, theoretical bases, policy definitions, or assumptions. In turn, this will allow users of the system to easily query the system for all items with a particular property. For example, in a strategic planning environment, a user (or builder) could easily ask for a listing of the corporate policies impacting a particular line item. Just as easily, the user could ask for an explanation of why a consolidated result changed in a given time period. Each question would be based on encoding specific types of knowledge into the system in relation to particular line items.

Expert system technologies can also be used in an EWS to handle user errors. In general, the process of learning to use any tool is characterized by a period of making numerous mistakes. When enough mistakes have been made to give the user proficiency in correcting mistakes, then the user is characterized as an expert. (There is some evidence to suggest that experts do not make errors at rates differing from those of novices, it is just that they correct them so quickly that it appears they make fewer.) Because a good portion of the errors associated with a particular tool are predictable (juxtaposition of letters when typing, etc.) it is possible with expert systems technology to have a tool assist in the correction of the mistakes. In the case of EWS, where a good portion of the problem solution procedure involves the creation or modification of documents (including text, graphics, and spreadsheets), building editor (text and graphics creation assistants) with detailed knowledge about the items being created will assist both the builder and the user in increasing their productivity. This will occur because the rate at which errors are made will be decreased, and the rate at which errors are corrected will increase. Examples of this run from simply automatically replacing the typing entry "more" with "more", to informing the user that a spreadsheet which is normally run with a database has been invoked without the database being available. In the latter case, an alternative such as 'proced' or 'open database', or 'stop' could be given to the user/builder.

Finally, EWS will utilize expert system technology in the area of graphical representations for processes and analyses. (In truth, this also draws heavily on other interface technologies as well.) Generating graphical representations of system information, data flow, and processing requirements, as well as data itself seems to appeal to a large number of people. These types of displays greatly enhance the ability of the individual to rapidly grasp global information, trends, and systemic behavior. The methodologies for transforming the text and process based information into graphical pictures rely
heavily on some of the representation techniques found in environments developed specifically for artificial intelligence work.

**Conclusions**

Executive Workstations will play a major role in assisting the executive with the increasing flow of data being generated by the internal and external environments. They will do this by simplifying and clarifying the way in which the executive can communicate with peers, subordinates, and the external world. This will be accomplished by assisting the decision maker in the analysis and interpretation of data, by making it easier to access fundamental data sources, and by assisting in the detection of anomalies and aberrations in plans as they unfold. EWS will offer the user new and powerful ways of interacting with the computer and the systems running on the computer, but more importantly, they will allow the computer to be utilized as a tool for solving the problems faced daily by decision makers in an increasingly complex world.

**References**