# visuos: A Visuo-spatial Operating Software for Knowledge Work

*Modular, integrated software could help knowledge workers keep track and make sense of abundant information by narrowing the cognitive load.*

By Dr. Clemens Lango

The second volume in the *Digital Horizons* book series has just been released by Synchron Publishers (Heidelberg, Germany). It is entitled *visuos - A Visuo-spatial Operating Software for Knowledge Work.* The author, Dr. Clemens Lango, developed the system in the framework of a research project funded by the German Science Foundation (DFG) and carried out within the framework of the Computational Design Program. The Program's director, Dr. Mihai Nadin, also acted as advisor to Mr. Lango's Ph.D. thesis, to which this research led. Terry Winograd and Reinhard Moeller were among those who evaluated the work.

After several years as an industrial designer, Dr. Lango obtained a doctoral degree in computational design. He has also developed the proprietary interactive information devices netalie and jaNet. His projects have received several international awards.

This volume is a hybrid publication: The book (print medium) goes into the details of the concept; the associated Website (interactive multimedia) allows the reader to become familiar with the system through a large number of examples.  These can be accessed at the visuos Website: www.visuos.com. Specific information on the book is given on the pages dedicated to the *Digital Horizons* book series: http://www.dhorizons.org/index.htm
For information on the publisher, go to http://www.synchron-publishers.com

**Access to Knowledge**

Today's knowledge workers have access to endless amounts of information. But this information is of no use if it cannot be reasonably retrieved and organized. When looking for good tools to accomplish this, one finds a collection of heterogeneous, inconsistent, separate environments that are not optimized for efficiency in the higher workflows typical of knowledge work.

visuos is the concept for an operating software for knowledge work in open networks. It addresses various forms of access to knowledge spaces, including knowledge management, information retrieval/research/refinement, monitoring of knowledge resources, and automation and scheduling of tasks. Designed for a broad target group -- from novice to expert -- it has a modular structure that lets users adopt the system to their specific degree of experience and their corresponding form of access to knowledge spaces. The modules are integrated by a holistic conceptual model allowing effective workflows across them.

The concept underlying visuos unifies classically divided systems, such as the personal computer "desktop environment," and network software, such as browsers, search engines, and ftp, in one platform. Different conceptual models and interaction standards of classically isolated public or private information spaces, such as local information spaces (represented by the operating system's file management tools), public information spaces (represented by ftp tools), query results (represented by the query system's model), and sitemaps or link lists (represented by the publisher's model) are represented by the same conceptual model. This consistency minimizes learning effort and allows "natural" interaction among these (technically and historically) different systems. visuos is highly visual; it facilitates information load reduction by minimizing cognitive complexity through direct manipulation of data.

The system offers different forms of access to information. If an element is regarded as valuable, the user will assign it to a level in a hierarchic space for later retrieval. In addition to this user-driven object-oriented storing, the system records a linear time-based log containing all elements and system states. This is an automatically running background task. Any previous system state or element can be restored using this process-oriented archive flow.

Furthermore, the flow allows scheduling and automation of future tasks. Since it is treated like a space, it can be queried to retrieve elements or system states like any other (hierarchically structured) space.

The highly usable direct manipulative query interaction model is closely related to the system's representation of information spaces. Workflows across these modules can be accomplished naturally. The query module offers a visual, direct manipulative interface. No Boolean textual syntax has to be learned. Its tight coupling principle combines the definition of a query, representation of the results, and refinement in one interaction model.

The benefits of the system are a completely novel functionality, new workflows, a maximized target group, higher effectiveness and productivity, and a higher level of user confidence.

**Background - use and access of hypermedia**

Hypermedia resources can be used in many different ways, such as investigating a special subject of interest, continuously updating information on certain subjects (research fields, stocks, accessing current general news, entertainment and communication), or carrying out collaborative work.

Investigation and information retrieval processes may be driven by many different motivations: diffuse browsing, obtaining information about a subject, finding an answer to a specific question, refining and extending knowledge, or understanding the context of a subject. Communication and computer-supported cooperative work (CSCW) includes finding experts, cooperative (re)search, cooperative editing, discussion, data exchange and various sub-classes of these processes. Information is pure reception of content with only a minimal degree of micro-navigation. Two such examples are an isolated update on information (e.g., news) and continuous observation of a content's development over time.

**Interaction techniques**

A number of techniques are used in interaction with knowledge spaces. Which combination of these is applied depends on user approaches and degree of experience. Many researchers have tried to classify these techniques. Even though the processes they describe are similar to a certain degree, these researchers arrive at different definitions.

In Canter's study, such techniques have been classified as sub-classes of navigation:

* scanning -- covering a large area without depth
* browsing -- following a trail until a goal is reached
* searching -- striving to find an explicit goal
* exploring -- determining the extent of information given
* wandering -- globetrotting without purpose or structure.

**Core activities of interaction**

There are two central activities involved in working with knowledge spaces: reception and orientation. Regardless of whether the user is browsing without any particular objective in mind or is focused on finding concrete information, he will constantly alternate between reception and orientation processes until he finds content that meets his needs.

In the reception phases, a user's "moves" will be kept to a minimum. The focus of attention is close and remains on content alone. The selection and navigation will be fine-resolution -- usually within the structure offered by the content (e.g., sentence, page or temporal streaming of films). In the orientation phases, the user gains a global overview of multiple documents and resources. The focus is distant, more general and abstract. The user navigates by taking large, high-frequency leaps between many rough overviews.

## The challenge

*Infinite resources*

The main quality of open systems is that they can handle a practically endless amount of content. Everyone can access everything and actively contribute to the system by publishing content of any kind. The advantage is a liberal, democratic system. The disadvantage is a massive overflow of information. Even when focusing on a narrow, very specific subject, there will be many resources available which to a large degree will appear interesting to a user.

It is very likely that the user will be overwhelmed by, and perhaps enthusiastic about, the quantity of resources. The problem is that the user becomes dazed as he moves at high speed through a massive amount of resources and loses sight of his original objective. A great deal of time passes by in an interval that is subjectively perceived as short. Hours fly by, and while at the end the user may feel that he had been entertained while browsing, in looking back, he also feels dissatisfied because he "lost" time without being productive or getting closer to the information he was originally looking for. This phenomenon can be described as asynchrony between real and virtual time. With today's systems, only users who have practiced effective strategies for quickly rating and filtering content can keep this phenomenon under control. In the system under consideration here, strategies should be found to lessen the risk of information overflow.

*Narrowing the cognitive load on human cognitive measure*

The human mind can perceive only a limited number of elements at one time. In classical cognitive psychology, George A. Miller speaks of the "magical number seven plus or minus two." Since this value was aimed at static environments in the context of the dynamic nature of interactive systems, the number of perceivable elements may be even smaller. The system proposed here will by default restrict the number of elements represented. The criterion might be their relevance or hierarchy, for example. System levels not in the user's current focus should be omitted or at least hidden.

Chunking of elements reduces the absolute complexity of environments so that a mathematically higher number of elements can be presented to the user. By default, only a minimal amount of information about each element should be displayed -- especially in overview situations. Details should be displayed on demand -- either for all elements visible or only for the ones in focus.

Appropriate, easily perceivable solutions for representation and interaction with the temporal dimension need to be developed for all dynamic modules of the operating software, so that earlier states of the system can be easily recalled and handled. Work in knowledge spaces and hyper environments consists of various sub-processes. For each process an adequate functional model must be developed.

**Convergent meta-system for higher productivity**

The problem with most solutions currently available is that they seriously address only one or two of these processes. There is no real meta-system integrating everything into one homogeneous solution, although only such a structure could minimize friction between the sub-modules and lead to a maximum degree of productivity within knowledge spaces.

Take for example a query from which the user: follows one result, makes several decisions by linking to further connected elements, wants to recall an earlier state to choose a more promising trail, finds an interesting document, and wants to sort this document into his local private workspace.

If these sub-processes were handled by different applications, the user would perform many distracting transitional steps in addition to those actually intended. Furthermore, each of these systems speaks its own interaction language, which has to be learned. It is nearly impossible to learn the languages of three to five different systems and still have a smooth workflow because in each sub-process, the user would have to adapt to the corresponding interaction language. The reason for this lies in the difference between the interfaces of the applications and their mostly abstract forms of representation.

One single meta-system with an object-oriented visual representation of all elements and processes would allow the user to remain very close to his actual objectives without being distracted by multiple interaction structures and gaps between different systems.

**Modular system architecture**

The operating software must be scalable in order to offer the simplicity necessary for novice users and to offer the higher degrees of control and productivity demanded by expert users. Its structure must be adaptable to multiple requirement profiles originating from the various approaches to knowledge work. These two variable requirement parameters place high demands on the flexibility of the system architecture. As a solution, a modular system architecture will have to be defined. This could support the demands of all user classes, as well as the variable requirement profiles of each user's approach.

**Interface issues**

A broad spectrum of approaches to knowledge work exists. Different users have different objectives and their degree of experience varies.

The challenge of developing a system that meets all these demands is not trivial. It involves an open system that provides a set of modules for different classes of work with knowledge spaces that in turn need to be integrated by a holistic conceptual model. Depending on his degree of experience and specialization, a user might, for example, enable one or two modules. If he is an expert, he may open an additional module or even all of them simultaneously so as to have direct control over all aspects of interaction with knowledge spaces. The system must offer alternative interaction models and forms of representation -- from text-oriented to concrete visual.

Another way to meet advanced or specialized demands is through the use of module settings. System modules will allow detailed configurations by offering a wide range of settings.

These customization strategies are highly desirable for meeting the whole spectrum of all user- and task-specific needs.

**Finding the right level of module granularity**

If a module's functionality is not limited to an actual activity in work with knowledge spaces, the user might be presented a module that contains more functions than he needs for a specific task. That is, he would be confronted with an unnecessarily high degree of complexity.

The user interface architecture principle must also be taken into consideration. The more a software module diverges from the scope of one specific activity, the more it tends to become a universal solution for different classes of activities. The consequence is the loss of the foundation for a clear structural identity, and the inability to develop the characteristic conceptual model for the user interface. This would result in a less usable and less productive interface.

In advanced forms of work with knowledge spaces, combinations of multiple modules will be used. These have to complement one another in order to accurately meet the functional requirements for the corresponding activity. The quality and effectiveness of the system depends on the extent to which the modules and the interaction with them is linked and how friction and loss in workflow across the modules is minimized.

**The visuo-spatial paradigm**

In the real world, everything visually perceived is in a continuous flow. There are no "cuts" or "jumps," since a human being is bound by physical spatial dimensions. The essence of hyper systems is that one element can be linked to every other element no matter where in the world it is physically stored.

In principle, "jumping" from one element to another is the opposite of a continuous flow. But since human cognition is part of the physical real world, it is targeted towards visually represented continuous transitions. Cuts in artificial environments that are not visually represented have to be consciously memorized and represent a massive cognitive load. In this respect, many conventional operating systems do not solve the problem of organizing objects and system states.

Locations represented within a consistent spatial system can be stored in a person's spatial short-term memory and do not require cognitive processing. The task of information assimilation is offloaded from the perceptual system to the cognitive system. These visualization principles lead to a higher speed and a higher bandwidth that the user can process.

The optimum would be to find a spatial mental model representing the hyper system in a way that can be perceived as a continuous spatial system. In this spatial system, the perception of changes in perspective could be supported by visualizing them through animated transitions. Only if needed -- in isolated cases -- appropriate "magic features" that go beyond the spatial model might be introduced. Werner Kuhn defines "Magic in a user interface [...] to be a liberation from the constraints of the physical world, taking advantage of the flexibility inherent in software."

References

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