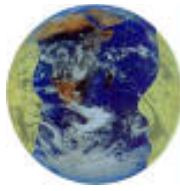




Electronic Publishing

For Learning (EPL)





An Overview of Electronic Publishing for Learning

A note to the Reader:

This PDF document is a collection of works originally created between 1990 and 1995. The original works were never intended to form a coherent collection and there has been no attempt to update them to do so. My purpose here has been to preserve these works for their historical value and to provide people interested in understanding EPL a body of reference materials to assist them. Though the content, particularly in technical details, is in some ways, ‘aged’, it can nevertheless provide an interested reader with an understanding of the basic conceptual of EPL (which remains as relevant as ever to the needs of learners). I encourage the reader to initially suspend concern over specific implementation details and instead let the ‘whole’ of EPL’S design intentions sink in.

To understand the context of this document it is necessary to understand that EPL is a way of implementing a vision about the nature of human learning. Though this vision is touched on in the **“Introduction”** and **“Premises and Orientations”** sections of this document, you can learn more about the learning vision at <http://www.implicit.com> and more on the story behind EPL at <http://www.implicit.com/epl/>.

The initial **“Introduction”** pieces (pages 1 through 5) are the oldest (1990) and are included to give a somewhat oversimplified place to start. Many of the same ideas are put forth and refined in the next section **“Premises and Orientations”** (pages 6 through 15) but this section’s real importance is in conveying the assumptions about learners, authors and curriculum that still hold today. The remaining 4 sections provide details about the system’s components and underlying technology concepts.

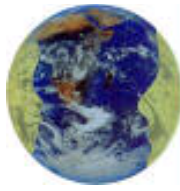
“The Learner Interface” is designed to bridge the learning or *meaning needs* of learners with the systemic learning needs of educators, instructional designers and curriculum providers.

“The Authoring Tool” renders virtually transparent all concern for software level file management and content connections (links), allowing authors to focus on the orders, contexts and meanings they are articulating.

“EPL General Outline” describes the modules of functionality between the Authoring Tool and Learner Interface.

“The EPL Learning Loop” details how the flow of feedback between the Learner Interface, and Authoring Tool is managed by the feedback Visualizer.

David Boulton
August 2000



An Overview of Electronic Publishing for Learning Table of Contents

Introduction	1
A Metaphor	1
What is EPL?	1
System Overview	3
System Components	4
Premises & Orientations	6
Background	6
Orientation to the Learner	7
Orientation to the Organization & Curriculum	10
Orientation to the Authors	11
Orientation to the Technology	11
The Learner Interface	15
Reference	16
Representation	17
Participation	18
Navigation	19
Compass	20
Collector's Case	21
Other Functions	22
The Authoring Tool	23
Navigation and Tool Menus	24
Representation and Attribute Assignment	25
Reference Tool Window	26
"On Open" Scripting	27
"All-At-Once" Meaning Module View	28
Changing The Face of the Interface	29
EPL General Functional Overview	30
Course/Outline Generator	30
Representation Editor/Generator	30
Link Maker – Quiz Maker	30
Representation Type & Attribute Assignment	31
Reference Processing	32
Authoring System Compiler Script Outlines	33
Learner Interface Script Outlines	34
The EPL Learning Loop	35
The Visualizer	36

Electronic Publishing for Learning



A Metaphor

Perhaps the best way to first approach the Electronic Publishing for Learning system being developed by DiaCom is through a metaphoric example.

Imagine an electronic microscope specifically designed for learning from information. A simple and economical device, designed to receive very special kinds of "slides"- slides that carry their own lenses.

Now, imagine that each slide has two such sets of lens -"multi-sensory" lenses. One set allows the learner to look at the meaning of a "paragraph" from various points of view. The other set enables the learner to look at any word or term with various types of clarification or elaboration. A series of such slides would represent a course of study or data base.

When using such a device, should the learner feel the meaning is unclear, he or she can select the combination of lenses that bring it into focus. The "adjustments" act as a **Learner-Interface**, the "slides" are **Meaning Modules**. Together with the "microscope" we call this learning environment **Electronic Publishing for Learning**.

What is EPL?

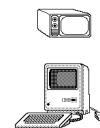
Electronic Publishing for Learning is a new learning environment and a different way of seeing the relationship between information intended to facilitate learning and learners. Its first principle is responsiveness: EPL is designed to be immediately responsive to the learner's rapidly changing needs for clarity and comprehension. Its second principle is meaning orientation: EPL responds to different levels of meaning needs; from help in understanding an element, (such as a word or multi-media object), to help in understanding a larger domain (such as a paragraph or thematic construct). Its third principle is "multi-learners": EPL is designed with a wide variety of learners in mind.

A New Learning Environment

In general, the facilitation of learning occurs through interpersonal relationships (teacher tutoring, group learning etc.) and information relationships (printed, recorded, or programmed information). A significant degree of today's curriculum is being facilitated by our relationship with information.



INTERPERSONAL RELATIONSHIP



INFORMATION RELATIONSHIP

The fact is that the most effective learning environment (intentionally facilitating) is, *necessarily*, one that can be adjusted by the learner according to his or her immediate *meaning- needs*, as they occur, and within the context and the objectives of the teacher(s)/designer(s). That is, an environment that provides each individual learner the tools necessary to adjust the experience to maximally engage his or her own cognitive learning style, reading vocabulary, native language, level of understanding of the subject, and appropriate unfolding pace.

The function of information, when created to facilitate learning, is to convey the *meaning* intended by the author (instructional designer or teacher), and to do so in a way that maximizes the learner's opportunity for comprehension. Textbooks fail learners not because they are not written in the right way, but because there isn't one "right way". There simply is no "one way", one universal narrative that can reach all learners. So, forced to conform to the one content, one form, one structure, necessitated by the "one-way" medium of printed books, generations of authors have learned to write texts for a stereotypical (and nonexistent) "average learner". There simply was not, and still is not, a way textbooks can be made to adapt to the *dynamically* changing needs of each learner. By the same token, the use of personal computers in education has not met expectations because thus far, these machines have been used to automate the "average-learner" model, not break through it.



The DiaCom environment subordinates form, structure and content to the author's intended meaning and the range of meaning-needs learners may have in relating to it. By using intended meaning as the basis for "linkage", content and resources developed to meet the needs of multiple learners can be correlated and made simultaneously available in the environment.

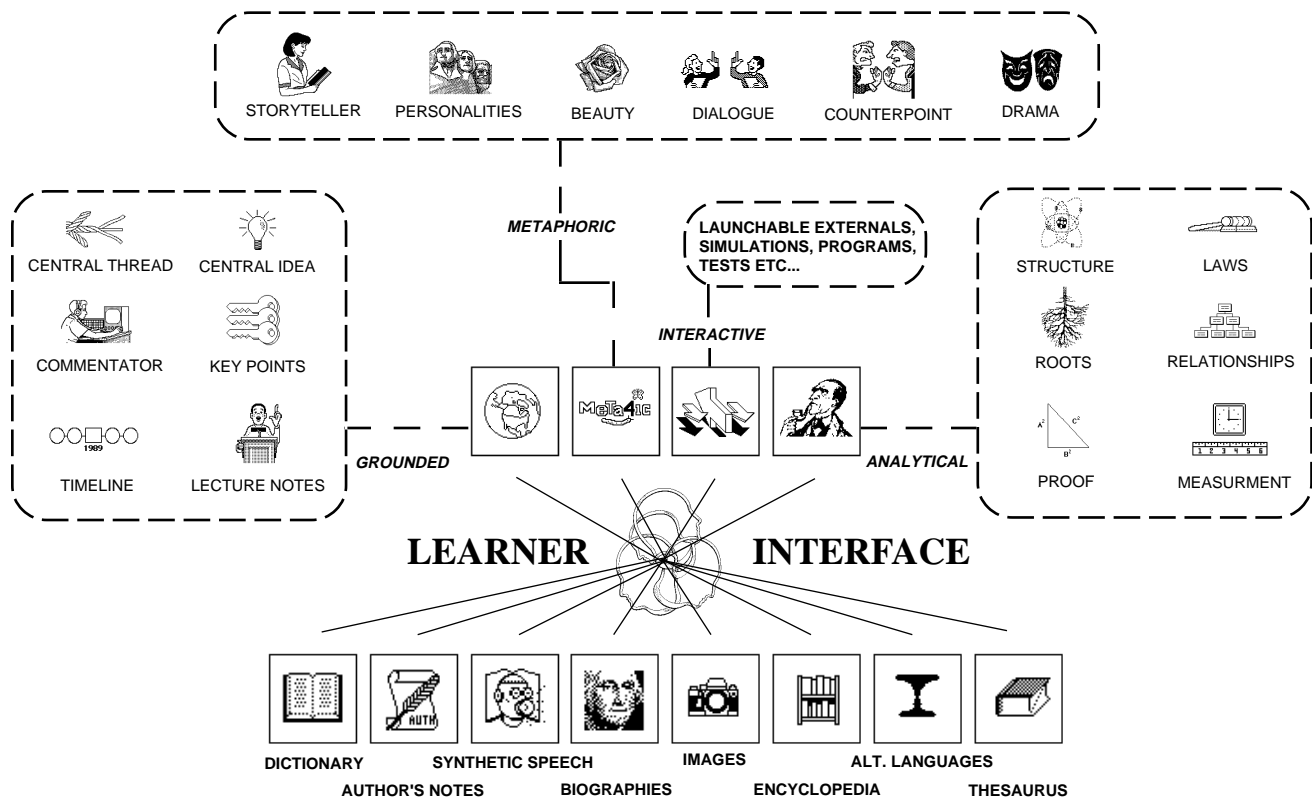
Each "meaning level" (word, sentence, paragraph) in a publication (courseware or database) is no longer restricted to the get-it or miss-it "average learner" structure. Rather, each level is supported by a wide range of information resources which have in common the same meaning, but that provide access to that meaning in different ways. For example, each element of meaning (word or multi-media object) is connected (through intuitive icons) to such references as definitions, synonyms, illustrations, etc. Similarly, each paragraph or thematic construct is connected to alternate ways of expressing its intended meaning, including alternate languages, representation styles and levels of difficulty or depth. Together, these two levels of support enable the learner to "adjust the focus" by selecting the information that is more meaningful to him or her. Moreover, and most importantly, the process of adjustment is not predetermined by the author or the environment, but occurs "live", performed by the learners themselves, as their ever-changing, ever-immediate, needs arise.

Electronic Publishing for Learning System Overview

DiaCom is developing a general purpose electronic learning environment. This system is being designed entirely from the vantage point of a learner needing *more* while trying to understand and move through learning materials. The environment's first design priority is to provide a new general relationship between learner and materials - a relationship that encourages learners to be sensitive to their own meaning needs and to critically employ them in controlling the environment.

This software environment will permit learners to self-direct and select learning materials according to their abilities, prior level of knowledge, learning style and *immediate* personal needs. By encouraging learners to declare, at virtually anytime or place, their uncertainty or curiosity impulses, and by subsequently providing the tools and resources that help them clarify and resolve such impulses, the environment transforms obstacles encountered during learning into opportunities to learn *to learn* while overcoming them.

The system is designed to be responsive to the learner's dynamically arising uncertainties and curiosities at two levels: clarifications, definitions, illustrations, pronunciations and encyclopedia elaborations respond to "elemental" meaning needs; alternate representations, dynamic simulations and launchable external programs respond to "construct" meaning needs. Both levels are represented by a unique set of Icons. Elemental level categories include concise support: dictionary, thesaurus, pronunciations, author's (or teacher's) notes, alternate languages, images, and elaborative support: encyclopedia and biographies. Construct level support has four major categories: grounded-practical, metaphoric-intuitive, analytical-logical and interactive-simulative. Each such major category mediates access to sub-classes of representation. For example selecting metaphoric could yield:



The environment uses the Macintosh to generate multi-media learning materials which can be distributed by networks and a variety of media. It can also use MS-DOS platforms, the Macintosh, the Apple II, and other new platforms to deliver the materials.

System Components:

1- The Learner Interface: Optimized entirely for the process of learning and applicable to virtually all subjects, the Learner-Interface allows learners to adjust a continuum of multi-media materials to suit their own unique learning/ comprehension needs. The interface provides an intuitive navigational system which makes learning more effective by allowing the learners to self-direct their progress through each encounter with obstacles or curiosity. The interface can run on all personal computer platforms, thus giving educators a way to seamlessly integrate their work and learning.

2- The Authoring System: The learning materials are developed on the Macintosh by an authoring system which can support single or collaborative authors/teachers. The system generates powerful multi-media learning experiences that can be delivered via the interface to ultimately all types of personal computers, and eventually, on an entirely new class of delivery system.

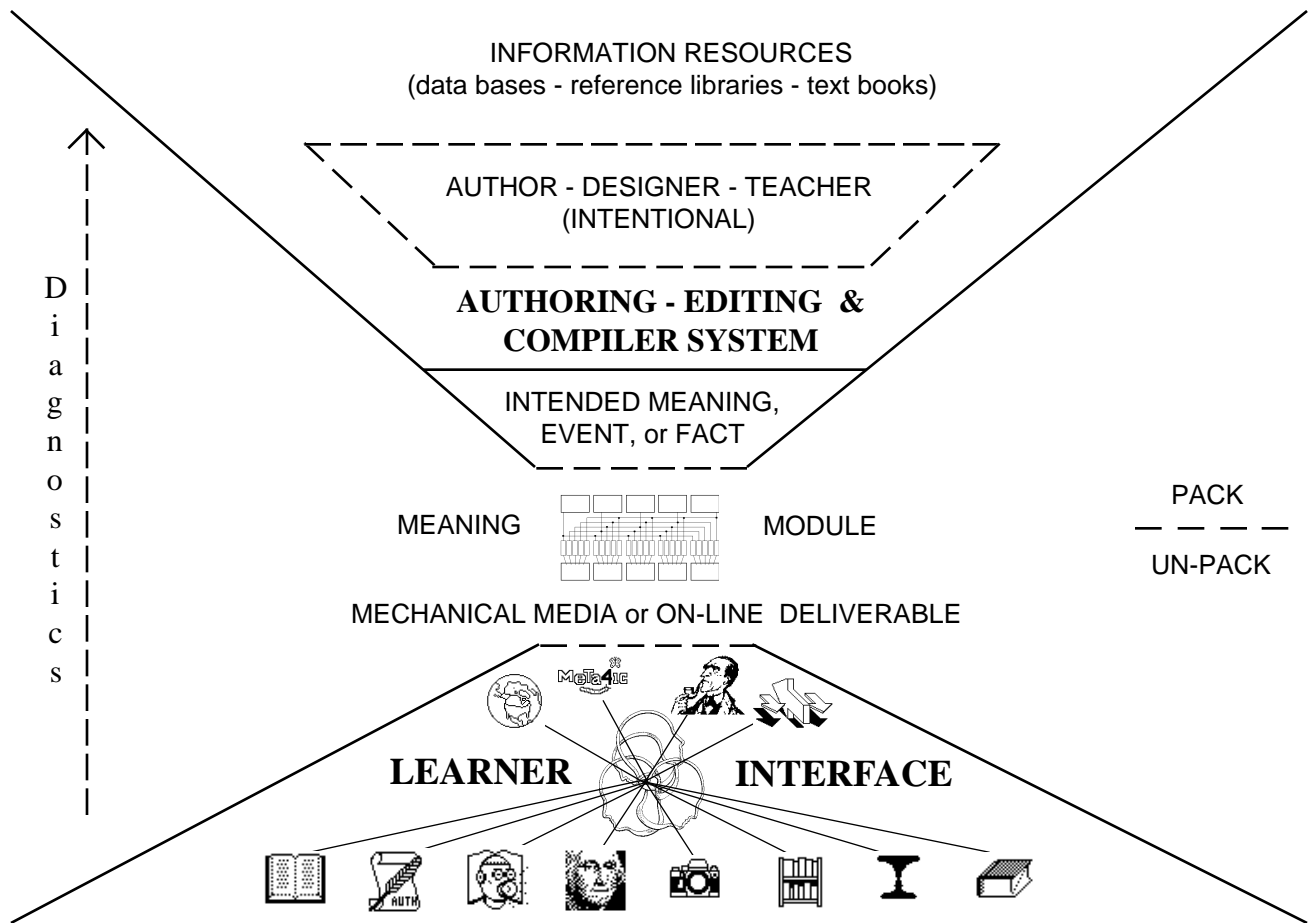
3 - The Learner Diagnostic System: As a learner navigates through the information a path is recorded. Each time the learner encounters an unknown word, requires clarification of a point, or chooses to have information presented in an alternative learning style his or her choices are captured. These selections are next interpreted by a diagnostic program, operating on either an MS DOS or Macintosh machine, which produces a "learning map" for the instructor highlighting areas which may require more personal assistance. When summarized, these diagnostics highlight areas for additional course development and provide instructors with a better understanding of the learner.

4 - Hardware: Because the environment is based on a different approach to processing and relating to information it makes possible the development of an entirely new and complementary family of peripherals and platforms. These include new kinds of storage devices that can significantly boost performance on older personal computers, a new way to network multi-media experiences on existing platforms and a family of Personal Learning Systems most significantly including a powerful yet economical and portable, Electronic Book.

Relevant Random Access: What makes these opportunities possible is an underlying information processing technology based upon a different approach to organizing data bases intended to facilitate learning.

Multi-media learning experiences can be seen as a flow of learning events. Each event is surrounded by a rich resource of supporting visual, graphic, audio and text-based materials which can be called upon to amplify and enrich the learner's experience. The traditional approach is to develop a body of course materials into a single large data base (or a course connected to series of separate databases). The learner then travels through the course, accessing from within it or other on-line databases those materials required to support any one event. The difficulty with this approach is that each meaning-need-event may require search and mechanical access delays. Thus, responsively supporting the learner's needs from within the large random data base of materials requires significant processing power and speed.

With the new technology, the database is a link-map, a top level organizer of smaller, nested, event-optimized databases. Each event database or meaning module is a self contained mini-library of resource materials relevant to overcoming the possible obstacles or sources of curiosity arising within a specific event. By compiling courseware in this manner, the overall processing requirements of the hardware and software are split into two categories. One is the movement from event to event. This is either regulated by the courses internal order or by the learner's own navigational requests. The other is the delivery of event-relative support materials. This is now dramatically expedited by the fact that these materials are already resident in RAM when the learner needs them.



By designing an authoring system to generate such courseware and an interface to navigate among retrieve, and manipulate the modules, powerful learning experiences can be delivered on comparatively low-powered platforms. The modularity of the software also provides a way to integrate the work of authors and publishers with teachers. Rather than needing a comprehensive understanding of the overall course and its software details, teachers can call up a published module and simply add whatever they want to its contents. The compiler will reinstall the module within the overall course or database and the Learner Interface will automatically respond to the updates. A more robust, future, version of this method of meaning-centered modularization can be facilitated by on-line A.I. agents which dynamically compile the modules in response to learner inquiries.

Finally, this method enables the development of entirely new and more economical hardware platforms designed exclusively for receiving such electronic publications for learning.

INTRODUCTION

PREMISES & ORIENTATIONS

BACKGROUND

Our society needs excellent workers and students. Toward that end, over 500 billion dollars is spent by industry and government each year. Excellent workers are students of their work - excellent students work at their learning. The most central and common attribute of excellence in workers and in students is *how well they learn*. We use “learner(s)” from here on to represent and mean both.

In a recent book by Peter Senge (of MIT’s Sloan School of Management), “The Fifth Discipline - The Art and Practice of the Learning Organization”, organizations and the people who work for them are seen as complexly related learning systems. Throughout the theoretical and applied organizational sciences, from Fortune 1000 meeting rooms to the business schools of every major university, the emerging paradigms all center on improving organizational and individual learning. As organizations struggle to improve quality, responsiveness and efficiency amidst change and uncertainty they are coming to realize the practical implications of Demming’s phrase: “the only sustainable advantage [of any organization] is learning”.

Driven in part by the crisis in education, many new approaches to facilitating learning are emerging. Learning to Learn, Critical Thinking, Self-Esteem, Constructionism, Learning Styles, Multiple Intelligences, Accelerated Learning and other “movements” are all beginning to contribute. Work being done in various branches of cognitive science, developmental psychology, and humanistic psychology are, in conjunction with these movements and the enormous pressure to reform education, leading toward a massive shift in the very mission of education. Educational research and the needs of business are aligning toward a new definition of what it means to be “educated”.

While it is no longer clear what knowledge and skills will be relevant to the needs of business and hence to the preparation of today’s children, it is glaringly obvious that business will need and the children must become better learners. The difference between yesterday’s educated persons and tomorrow’s life long learners is the emphasis that will be placed upon their capacities for ongoing learning. The implications of this require and are precipitating an inversion in education’s most fundamental priorities: Whereas in the past education has viewed a student’s capacities for learning as the *means* through which knowledge and experience is acquired, the future will use knowledge and experiences as the *means* to extend and enrich a learner’s capacities for learning. To become more learning capacity *oriented* education is shifting from an emphasis on producing “knowers” to stewarding “learners.”

Businesses need learners and they need products and services that can help them learn how to translate their strategic plans into effective curriculum, learning environments and learning experiences that will develop and extend the competencies of their learners and the organizational systems that interface them.

DiaCom is a company developing products and services entirely designed for facilitating the capacities for learning in individuals and organizations - for serving the emerging “learner” market. Based on years of research into the fields and disciplines relevant to the issues of learning, education and business, DiaCom is poised to create and market a series of breakthrough products.

ORIENTATION TO THE LEARNER

Based on research into what constitutes an excellent learner, DiaCom discovered that:

- Both in terms of interpersonally and informationally facilitated learning, the capacities of a student to employ “critical thinking skills”, to formulate a “good question”, to “construct knowledge”, to “abstract coherently”, to avoid “premature closure”, to avoid “tendencies toward self-deception”, to live with “ambiguity” and perhaps most importantly to *creatively learn*, is the learner’s both tacitly spontaneous and consciously instrumented response to his or her own fluctuating meaning needs. Comparatively, everything else is habit acquiring new habits.

“Meaning needs” refers to the impulses of desire, curiosity, uncertainty, ambiguity and creativity. Impulses, that underlie, give direction to and emerge within conscious awareness and activity. As these impulses fluctuate in various contexts, **how the learner has been habituated to or has participatively learned to respond to them** (consciously and/or subconsciously follow through with or suppress them) **is at the core of his or her capacities for learning.**

These attributes stand in marked contrast to our education and business learning systems as they are currently oriented toward relating to learners through a *timescape* grossly out of sync with where and **when** the most critical aspects of developing the learner’s capacities for learning are taking place.

Over the 13 years of K-12, students spend thousands of hours sitting in classrooms experiencing presentations and formal activities that by their natures evoke and then circumstantially prohibit the students emerging meaning needs from getting attention or being followed through with. One teacher, fifteen to forty students. If during a class lecture, a movie or exercise, a student has meaning needs related to details in the flow, what happens? What can they do?

For young children the capacity to be uncertain or curious is in marked contrast to their ability to articulate what it’s about. Meanings can be moving by at a pace so foreign that the child can’t even consciously know, let alone articulate, what has or is causing them to “need more”. Some older students do stand up or raise their hands and say “excuse me - stop - I am curious about your use of the word (x)” or “what do you mean by (y)”. **But it isn’t the rule.** Even for those not intimidated or those able to stay in sync with the class, thousands of uncertainties and curiosities are ignored for every one acted upon.

Over those 13 years, how many hundreds if not thousands of hours do children spend with

a book in their hands? Again, what can they do when they encounter a word, term, phrase, concept, method of presentation, etc., that either evokes curiosity or uncertainty - that causes them to *need more*? Put the book down, break engagement with the flow, and seek help from the teacher or reference library? Skip along hoping the meaning of the word will emerge in context?

Obviously, most students just learn to ignore all but their most powerful impulses. They learn to suppress following through with them not because they are **discerned as meaningfully irrelevant or inappropriate**, but because they are *circumstantially* irrelevant or inapplicable - because the environment was never designed to respond to them at that level. Slowly but surely the circumstances of this insidious curriculum, of a student's "background" relationship to educational experiences, mount up to a deadening of his or her inner responsiveness to his or her own meaning needs. They may "learn to know a lot" but to a substantial degree at the expense of, rather than the extension of, their fundamental capacities for learning - at the expense of what will enable them to become better learners. Thus the pervasive lesson of education has been to learn to separate from, suppress and tacitly invalidate the intrinsic movements which are the fountainheads of the learner's capacities for learning.

DiaCom's research into these issues led to the questions:

- If learners can't trust their own learning (meaning) needs as the primary compass from which to orient themselves to learning - who or what is learning?
- How can learners learn to tune into trusting their own meaning needs without a relationship to their learning environments which is responsive enough (in time) for them to follow through with them?

As developing the learner's capacities for learning is central, and the learner's **live** participation in the movement of his or her meaning needs is central to his or her capacities, then it follows that the central mission of education will emerge to become the encouragement and facilitation of a **learning oriented subjectivity**. Learning oriented people - learners are what business needs and education is evolving to develop.

Recognizing the opportunity for a series of products and services that would be designed to facilitate specific learning objective mastery while co-equally developing the learner's capacities for learning, DiaCom's design question became:

- In the context of the relationship between learner and learning environment (informational and/or interpersonal and/or intrapersonal), what are the attributes and qualities of environmental responsiveness which are necessary to encourage and facilitate a learning oriented subjectivity in the learner while at the same time maximizing the learners' specific mastery of the subject at hand?

Proceeding with a design sensitive to all the issues discussed above, DiaCom developed a model of relating learners to their learning environments and has prototyped it in what is called the "**Learner Interface**" (see Learner Interface).

The Learner Interface is designed to rapidly respond to the following types of meaning needs through a series of Icon accessed situationally relevant menus:

- A) Elemental** - word, term, phrase, acronym, image component - "Reference"
- B) Representational** - Cognitive Bias, Learning Style, Depth, Range, Language
- C) Navigational** - Structure of Knowledge, Personal Past Travels
- D) Personal Preferences** - biases in text, sound, image, scope and representation
- E) Record** - "Highlight" and save
- F) Feedback** - what works, what is missing
- G) Contribute** - Create and contribute to the community knowledge pool
- H) Other Help** - Help with the interface, platform or course

THE LEARNER INTERFACE

SITUATIONAL POPUP MENUS

— Navigational - Personal past travels
— Feedback - Send feedback related to what is highlighted
— Contribute - Create and contribute materials to support this context

You walk and move around easily because of gravity. You would need to relearn how to walk on the moon where the gravity is much less. The Astronauts found that a little jump on the moon's surface lifted them much higher off the ground than it did on earth. On the other hand, if the earth's gravity became stronger, you would feel weighted down. Walking would be tiring and difficult until you became used to the increased **gravity**.

Gravitation is one kind of attraction of one body for another. Because of gravitation, the earth attracts all other objects. A planets gravitational attraction for objects is its force of gravity. The weight of an object on Earth or any other planet is the force that gravity exerts upon the object. Weight is not the same as mass. The amount of material in an object is its mass.

- Elemental - access situationally relevant references
- Representational - access alternative representations of the meaning intended or pursued.
- Navigational - access other non structurally sequential materials
- Compass - sets personal preferences
- Record - Multiple "highlighters" for "collecting" information
- Navigational - access structurally sequential materials
- Other Help - Situationally responsive help (system or content level)

With the interface design providing the means to allow educational and performance support materials to be adapted dynamically to the needs of each individual learner and via

each learner's meaning needs, the next stage of DiaCom development centers on developing the "Organizational Interface", the "Authoring Tools" and the technological mediation systems which would support the movement of learning experiences between the organization (business or school) and the learners.

ORIENTATION TO THE ORGANIZATION & CURRICULUM

The implementation of corporate strategy requires the effective design and dissemination of interventions and learning experiences. As in education, curriculum design is a key. In order for curriculum (business or school) to be effective it must provide the scaffolding from which broad and detailed learning objectives actually become learned by learners. The questions involved in designing effective curriculum can be summarized as follows:

- What are the macro, domain/subject level, learning objectives the curriculum must facilitate?
- Within each domain what specific component learning objectives must be facilitated?
- Within each specific component learning objective what semantic transactions (meaning perceiving events) must occur for learners to master the objective?
- Within any one semantic transaction what cluster of alternative resources must be made available so as to make the general intention behind the transaction available to learners in individual ways. (Ways responsive to each learner's actual meaning needs as they arise in relating to the transaction or objective).

Parallel to these issues is the differentiation which must be made between the appropriateness of broad "off-line" interventions such as "courseware" and "classes" developed for general subject facility, and the need to support the "on-line" activities of learners while performing on the job or during inquiry and research driven learning. Ultimately it is clear that organizations (schools and businesses) need a seamless interface between both. Learners need both general facilitation and task specific performance support. While on the job a performance support need may require the learner to drop down into a more general learning experience. While in a structured curriculum segment designed for general facility with a subject, a learner's meaning needs may require a performance support like response. Independent of subject and content, DiaCom' Learner Interface is designed to provide for both.

The problems inherent in the design of curricula and in the development of learning materials designed to support them are formidable. One, if not the, most significant difficulty lies in the granularity of measurement. As tests are far off-line from the moment to moment level at which learning is occurring they provide very little feedback from which to better optimize the curriculum or learning materials. Consequently, curriculum and instructional design teams are forced to work from assumptions and models grossly out of touch with the actual learning needs of the people who learn from their products.

Based on research into these issues, DiaCom has developed a way to make this overall process more efficient by introducing what it calls “Mutually Learning Oriented Relationships” at each level of interface between the organization (business or school), its curriculum, its learning materials and the individual learner. The Learner Interface has been designed to capture unprecedented detail about each learner’s movement through the curriculum and to allow each unsatisfied meaning need to be easily articulated and flow back to the organization as feedback. This information about each learner is then topographically summarized and superimposed with other learners’ feedback to provide the basis for optimizing the relevancy and effectiveness of learning materials in previously impossible levels of resolution. This system, the “**Organizational or Curriculum Interface**”, will allow teachers to optimally match materials and instructional strategies to the particular needs of their individual learners. It will also allow, instructional designers and curriculum designers to see where to better focus their development efforts.

ORIENTATION TO THE “AUTHORS”

The Learner and Organizational Interfaces provide the basis for mediating mutually learning oriented relationships. Through the technologies of these two interfaces DiaCom can enable organizations and individuals to learn in entirely new, performance increasing and cost effective ways. Together they provide the basis from which DiaCom has developed a series of authoring and creativity tools.

The creation of specific learning materials by authors and instructional designers should not require the authors or designers to be computer programmers or think like computer programmers. Similar to the Learner Interface, our approach to authoring centers on responding to the needs of authors. Our design has been optimized toward providing the creators the means to express "what they mean" in many alternative ways and to do so by making the "programming, scripting, linking and compiling" totally invisible.

ORIENTATION TO THE TECHNOLOGY

In terms of electronic publishing, personal computer platform design, and the design of networks, the paradigm of the personal computer age has been random access. What a user will do or need next while in the middle of using a word processor, a CAD program or a spreadsheet is virtually unknowable. While systems designed to optimally respond to random activities are necessary to support “producers” there is a major difference between their needs and the needs of learners.

While there are occasions when learners will need to be able to randomly jump from one domain or subject to another, the most predominant and important needs have to do with responding to those that emerge while within the scope of a learning objective or inquiry. At any given time the learner’s resource needs can be seen as relevantly related to the meaning terrain the learner is in. References for words or alternative presentations of the meaning intended (or pursued) in the larger construct being learned, are all correlatable by their relevancy to the possible meaning needs of learners. In other words, as learners move through learning experiences they continually redefine the center of a relevancy bubble. Its

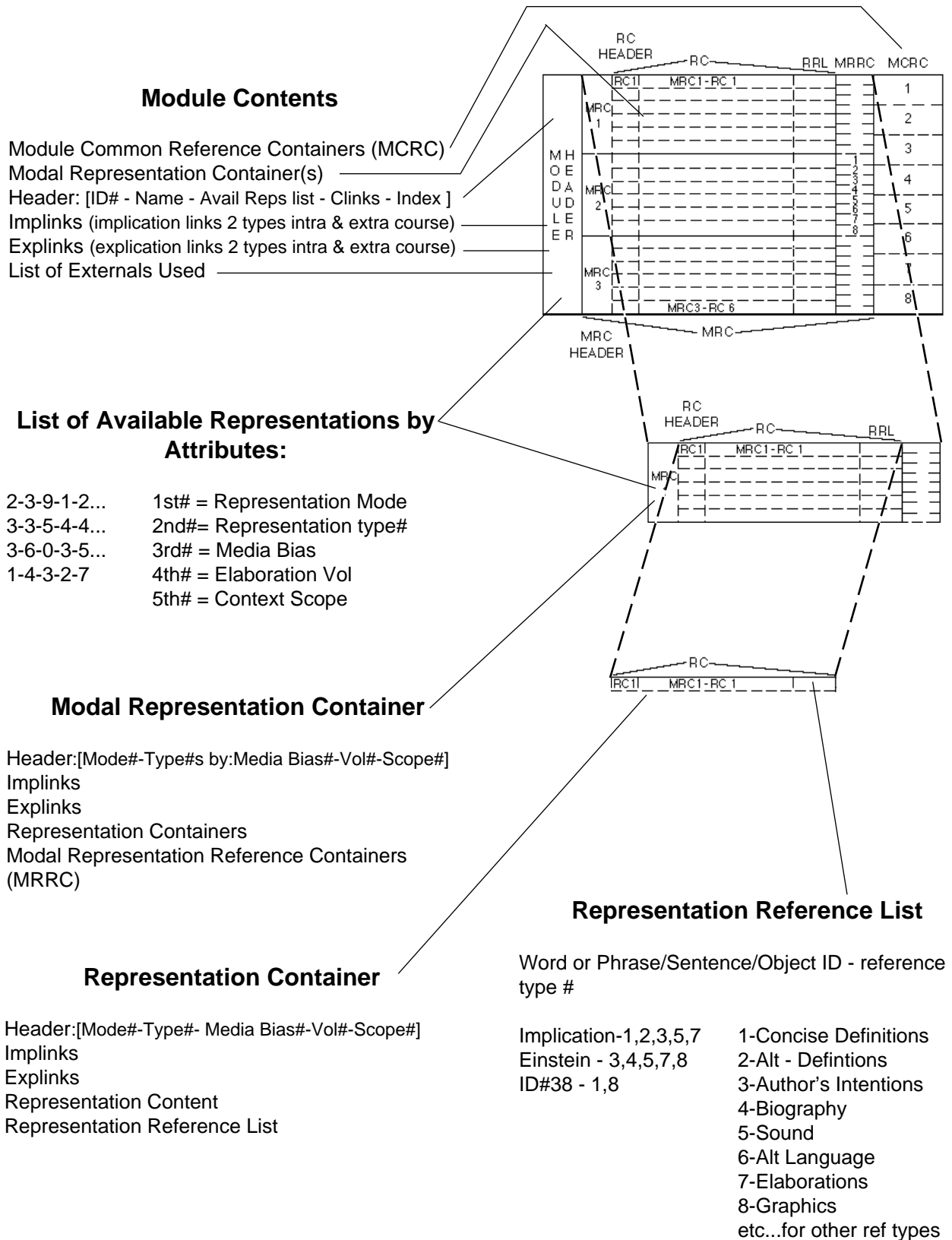
not that they won't occasionally need resources that can't be anticipated, but the majority of their needs are relevant to the situation they are in. Technologically speaking, the most important learner needs can be characterized as requiring situationally and relevantly bounded, random access. The design of DiaCom' technology is based on this notion which we refer to as Relevant Random Access (RRA). By orienting processor and storage access operations toward optimal performance within such relevancy bubbles, the price performance curves of storage devices, processing platforms and networks can be significantly enhanced.

At the core of Relevant Random Access is a new file type which behaves neither like a sequential file nor like a general purpose data base. Designed to take advantage of the fact that the learner's needs are not actually random; that they cluster strongly around the immediate learning transaction or objective, this new file type enables us to have in fast memory the secondary store addresses of all the information resources a learner can request from his current position, and further, to have as much as possible of the actual resources that may be called for in fast memory as well. This new file type is called a "Meaning Module".

The Meaning Module can be described as a learning objective resourcing micro data base. A key element of its design is its inner structure or geometry. Each module has virtual cavities and containers which store lists of resources and in many cases the resources themselves related to the learning objective the module serves. For example each word, term, picture or sound that might appear to the learner has a trigger that points to the module's reference list. Each item on the reference list has tags which identify which types of reference supports and where the actual references are located (internal to the module in one of its reference content containers or external to the module by store address). When the learner points to such a word, term, picture etc., (declares a meaning need) the system need only look to see what's available for that object by looking it up in the reference list. As this is in RAM the system instantly responds to the learner with a list of references by reference type actually available to support their needs. As the learner in turn selects from among these choices the system immediately presents the resource. If the resource selected wasn't in RAM the system knows exactly where to go to get it. This approach to relevant reference processing is also used to organize and store alternative representations of the entire modules intended meaning. Thus alternative languages, or materials biased to be suitable for learners with different levels of competency, cognitive bias and learning style can all be correlated for efficient processing and hence the critical meaning need responsiveness discussed earlier.

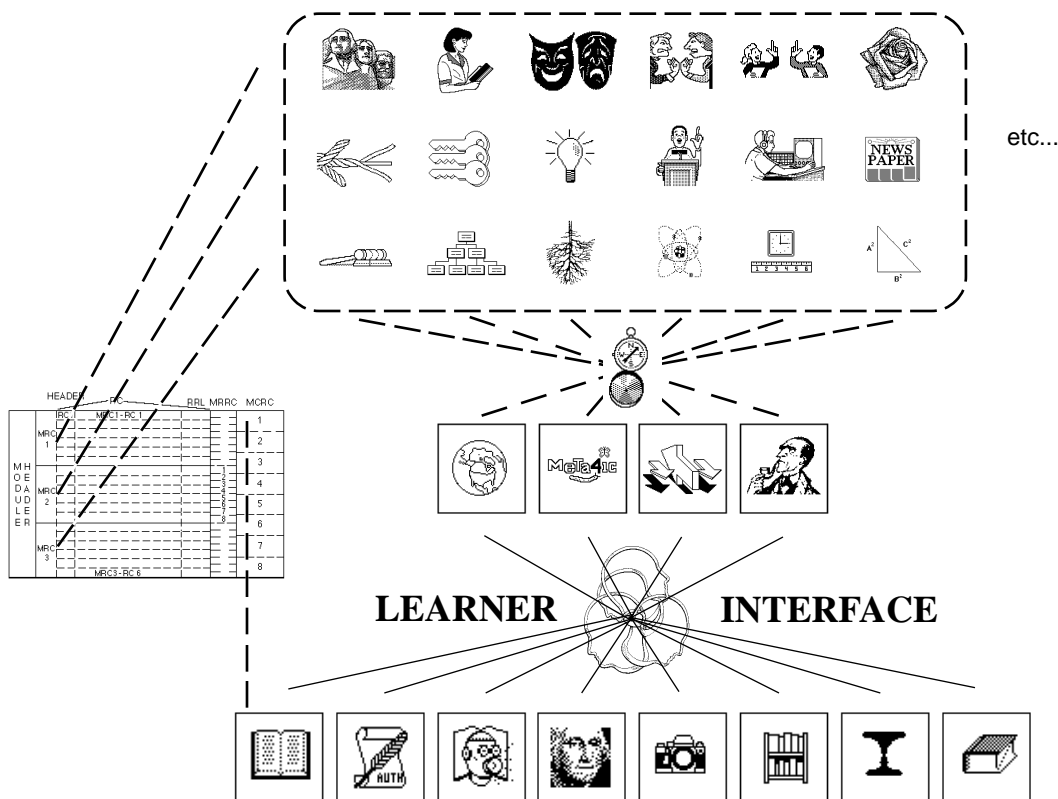
This approach to the correlation, clustering and compilation of resources provides a significant technical advantage. First linkage between resources within the module is accomplished by the module's structure. Though there are links between modules, the messy overhead of discrete links between objects relevant to the module is eliminated by the RRA distributed processing model inherent in the module's architecture. Discrete links are reduced by an average of 80-90%. In addition to the logistical and management benefits related to decreased links is the fact that links are not an efficient basis for preparing RAM content in hypermedia systems. To read all the links and then operate on those links to discreetly preload linked contents could require hundreds of unnecessary time consuming system transactions.

MEANING MODULE STRUCTURES



Thus the notion of a relevancy bubble is not supportable by a discreet link approach.

Second, because the module appears as one file to the platform, despite the fact that it may contain hundreds of resources, the system transaction overheads (network, storage device or platform) are drastically reduced. Contrast this second point with a traditional distribution of resources on a network or slow access storage device such as CD-ROM. If when a learner declares a need the system has to search out reference library indexes for each potential reference type available, with each one (dictionary, encyclopedia, image and sound libraries) potentially having hundreds of thousands of items and consequently requiring their indexes to be read from the storage source into RAM, the system transactions and overall time to present the learner with the available choices could well be 10 to 100 times the delay of RRA.



THE LEARNER INTERFACE

This is the main display area of the Learner Interface. To the right is the main control panel. The Learner Interface has been designed to provide a highly intuitive and leveragable interface between the learning *or meaning needs* of learners and the systemic needs of educators, instructional designers and curriculum content providers. The metaphor of the interface is a cross between "electronic book" and a "cockpit". It is an inviting, simple to use and extremely dexterous tool for helping people learn. *It is primarily a system that allows learners to **exercise** their capacities for learning.*

The product is being developed to run on Macintosh, Apple II, and MS-DOS computers and eventually become available for emerging technologies such as electronic books, home multimedia systems, CDI, CDV and game machines like Nintendo and Sega. The product can be bundled with electronic publications on disk or CDROM or be used in conjunction with networks or classroom servers. Though the quality of appearance and presentation speed of space intensive media types will vary across these platforms, the basic "look and feel" and *need responsiveness* of the interface will remain the same.

The layout reflects a near future vision when the interface will run on a "tablet" (about the size shown here) and the control panel on the right will be actuated by the learner's thumb (the panel will be configurable to the left for left handed learners).

With the simple controls shown here (and elaborated on the following pages) a learner is enabled to:

- Navigate the visible universe of materials
- Travel into a "meaning module" about a particular learning objective or subject
- Travel beneath the surface of words, terms and images to satisfy their *meaning needs*
- Spin through multiple representations of the module's essential meaning
- Send feedback to teachers, instructional designers and content providers
- Contribute their own "representations" or "research" to other learners or the entire system
- Collaborate with other learners in teams, locally or remotely
- much more...



QR^{ref}_{wick} REFERENCE

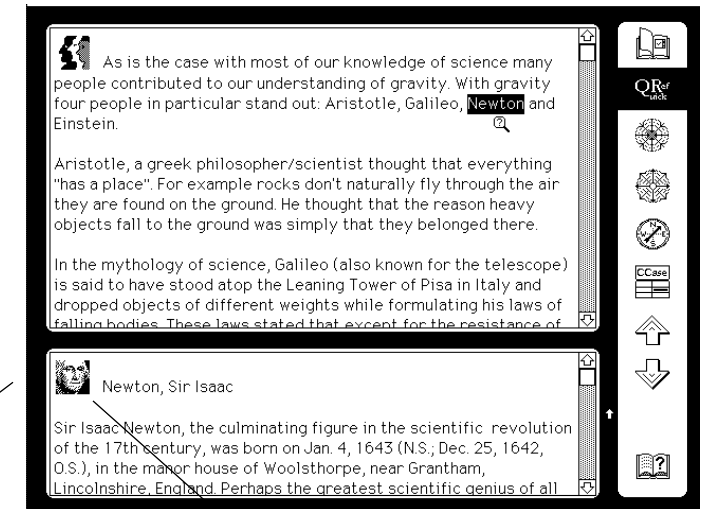
IMMEDIATE - CONTEXTUAL - CONCISE or ELABORATE - MULTIMEDIA

The first major class of meaning needs the Learner Interface responds to is elemental. Should learners have the experience of encountering an element of a learning objective (words, terms, phrases, images, etc.) that causes them to "need more", they point and click on it. If references are available, the learner interface instantly highlights the QuickRef menu. By depressing the Quick Ref menu the different types of available references instantly appear^{1,2}. Selecting among them causes the interface to situate itself appropriately and present the reference.

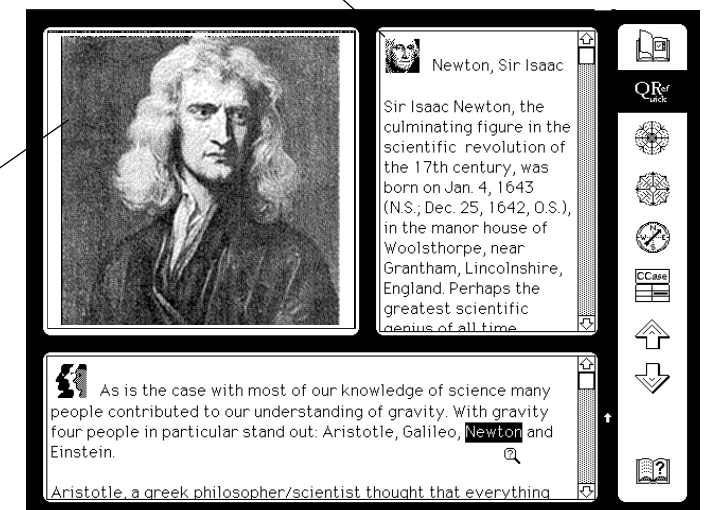
¹The order of appearance of available choices in the situational menu is conditioned by the "Compass" (see "Compass")

² If a preferred or needed choice (mode or type) is not available the learner can easily send feedback to that effect and/or create or contribute materials they find outside the system, as resources for future learners. (see "Participation")

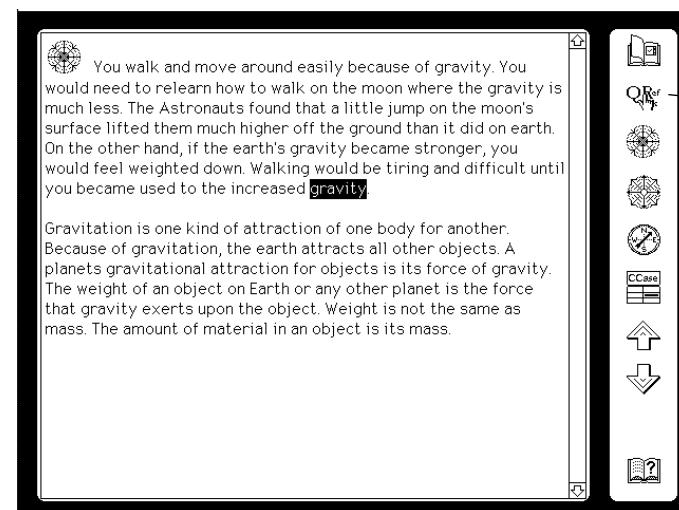
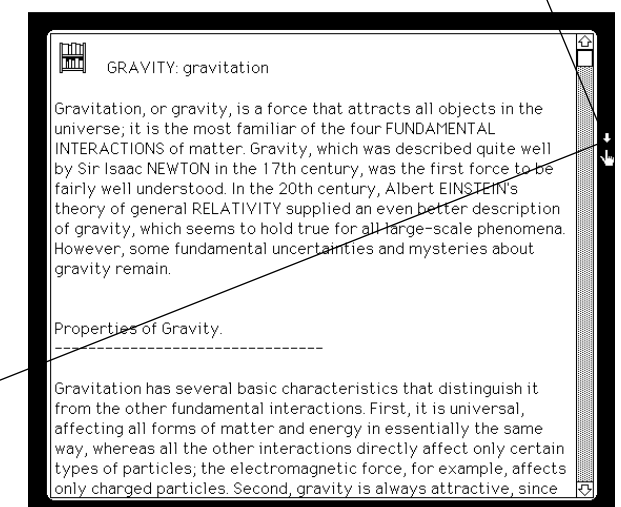
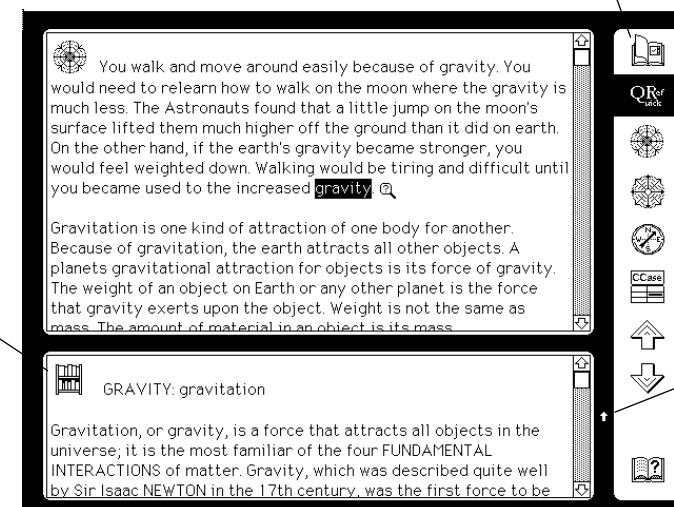
When a reference is selected the interface auto configures to accomodate its content.



When an additional reference is selected the interface re-configures to accomodate its content as well.

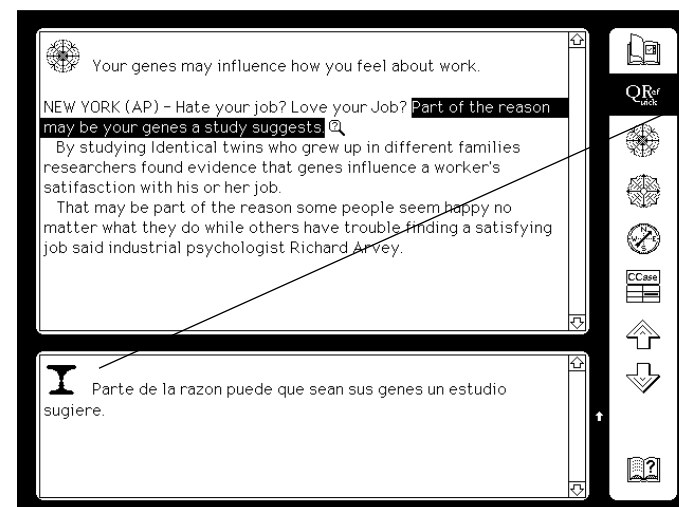


The reference material can easily be made to fill the screen or be instantly put away returning the system to its prior state.



QUICKREF Situational Menu
(only choices actually available appear)

- Dictionary (concise)**
- Thesaurus (concise alternatives)**
- Author's Notes (elaboration)**
- Biographical**
- Etymology**
- Quotes, Citations, Bibliographic**
- Speech, Voice, Music**
- Alternative Languages**
- Encyclopedia (elaborations)**
- Images**
- Animations, Video, Simulations**
- Other**



REPRESENTATION

COMPREHEND - INFORM - UNDERSTAND - EVOKE

The other major class of meaning needs the Learner Interface responds to is Representational. Should learners have the experience of understanding all the elements of a learning objective (words, terms, phrases, images, etc.) but still not have travelled deep enough or understood "what it all means", the learner interface enables them to instantly see^{1,2} all the available alternative modalities of representation and instantly choose^{1,2} among any of their available subordinate representation types.

¹The order of appearance of available choices in the situational menu is conditioned by the "Compass" (see "Compass")

² If a preferred or needed choice (mode or type) is not available the learner can easily send feedback to that effect and/or create or contribute materials they find outside the system, as resources for future learners. (see "Participation")

ALTERNATE MODE OF REPRESENTATION

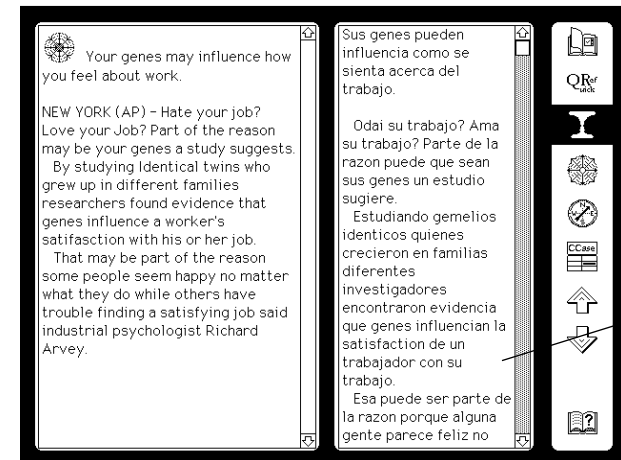
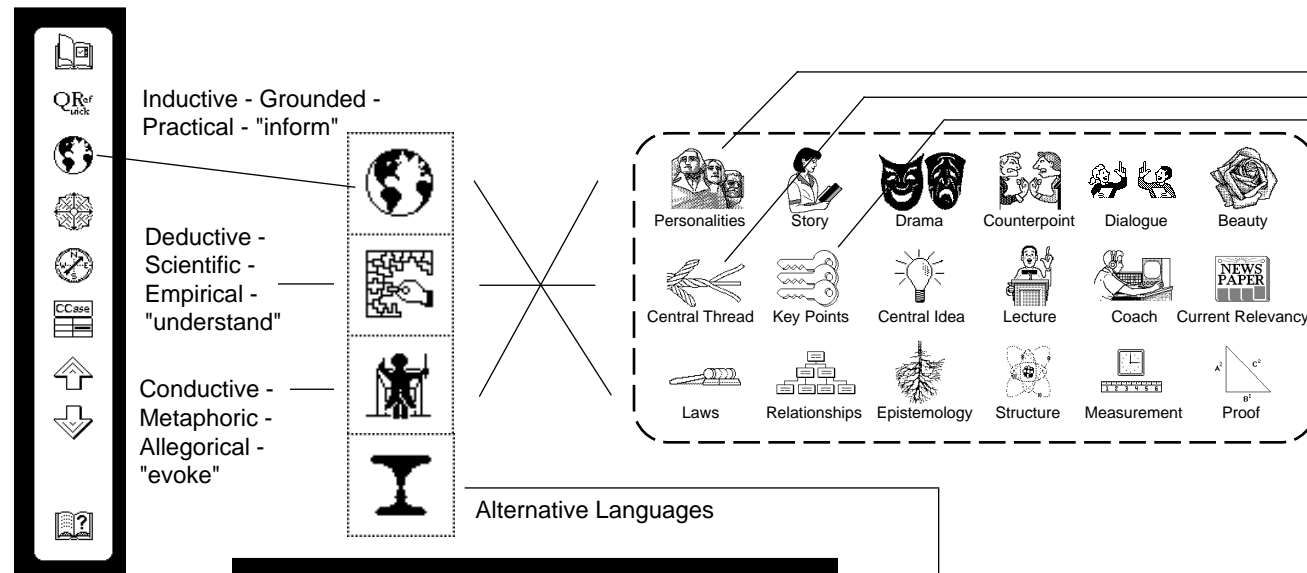
Situational Menu

(only choices actually available appear)

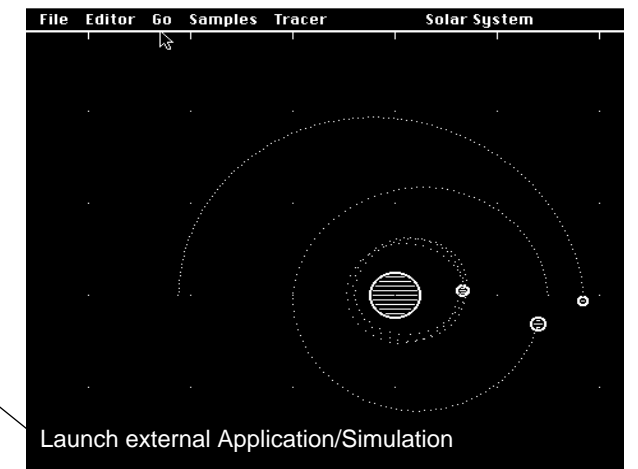
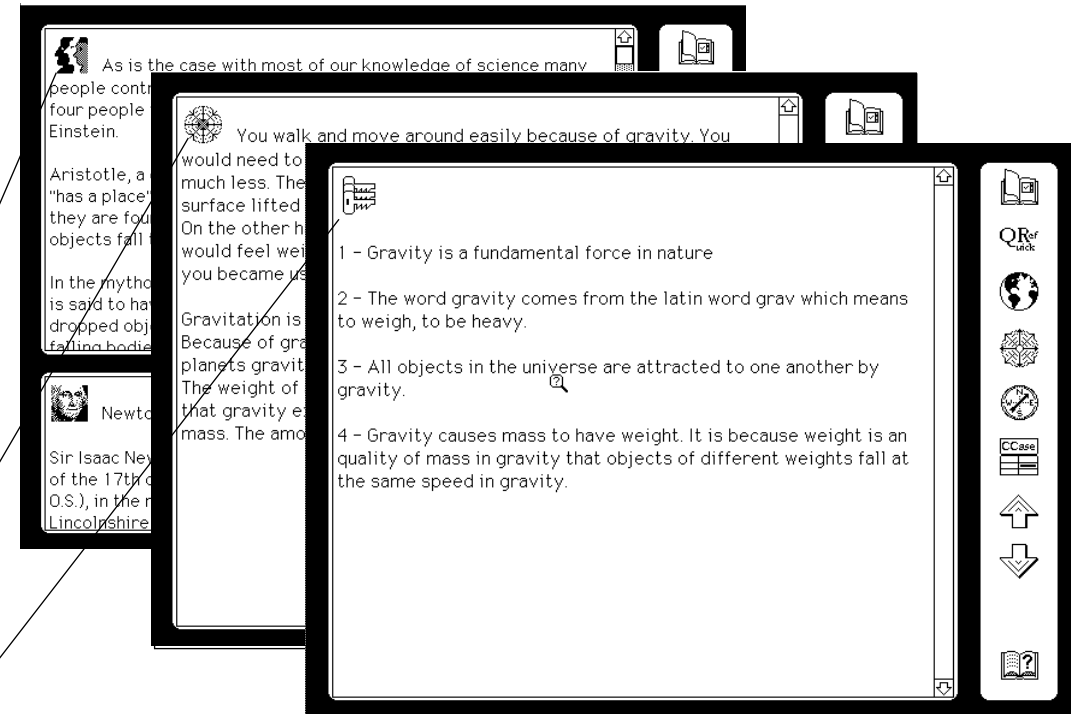
REPRESENTATION TYPES

SUB - Situational Menu

(only choices actually available appear)

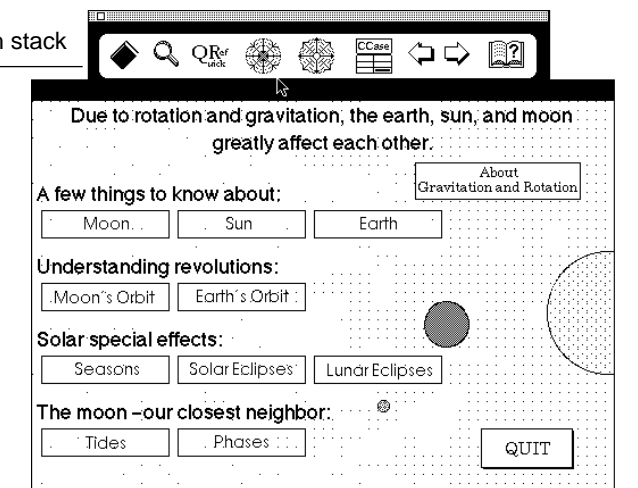
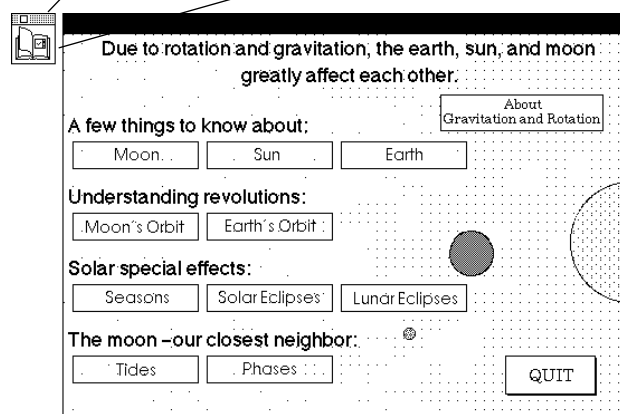


Select from menu of languages available in this case Spanish



Launch external Hypercard Stack

Interface suspends and "shuttle palette" appears along with stack





PARTICIPATION

FEEDBACK - CONTRIBUTE - COLLABORATE

Using a representation (present or desired) or a reference (present or desired) as a "context place marker" the structure of the material at hand provides the scaffolding to send feedback, contribute or collaborate.



In the FEEDBACK mode learners can inform the teacher, curriculum designers and content providers of where they had unfulfilled meaning needs - in seconds. In the first example below the learner is declaring that he or she wanted the root meaning of the word philosopher.

As is the case with most of our knowledge of science many people contributed to our understanding of gravity. With gravity four people in particular stand out: Aristotle, Galileo, Newton and Einstein.

Aristotle, a greek philosopher/scientist thought that everything "has a place". For example rocks don't naturally fly through the air they are found on the ground. He thought that the reason heavy objects fall to the ground was simply that they belonged there.

In the mythology of science, Galileo (also known for the telescope) is said to have stood atop the Leaning Tower of Pisa in Italy and dropped objects of different weights while formulating his laws of falling bodies. These laws stated that except for the resistance of

and / or

I think thought is the past tense of thinking and refers to...



In the CONTRIBUTE mode a learner can create or "paste" materials they wish to add to the "book" or project.

and / or



In the COLLABORATION mode a learner can create or "paste" materials they wish to share with other learners or the teacher.






TO: Steve --
Do you think Mr Smith is a philosopher?


NAVIGATION

SEQUENTIAL - GENERAL - PERSONAL PAST

The Learner Interface provides the learner with many ways to navigate. He or she can simply jog forward or backward sequentially within the material - "Jump" to somewhere else via index, table of contents, "links" or other "books" in the library - or travel back through their own personal past travels, revisiting references, representations or modules they want to be refreshed on.










Personal Representation History Menu


-  The Sun
-  Solar Energy
-  Orbits
-  Space Shuttle
-  Solar System

 As is the case with most of our knowledge of science many people contributed to our understanding of gravity. With gravity four people in particular stand out: Aristotle, Galileo, **Newton** and Einstein.




Aristotle, a greek philosopher/scientist thought that everything "has a place". For example rocks don't naturally fly through the air they are found on the ground. He thought that the reason heavy objects fall to the ground was simply that they belonged there.

In the mythology of science, Galileo (also known for the telescope) is said to have stood atop the Leaning Tower of Pisa in Italy and dropped objects of different weights while formulating his laws of falling bodies. These laws stated that except for the resistance of

 **Newton, Sir Isaac**

Sir Isaac Newton, the culminating figure in the scientific revolution of the 17th century, was born on Jan. 4, 1643 (N.S.; Dec. 25, 1642, O.S.), in the manor house of Woolsthorpe, near Grantham, Lincolnshire, England. Perhaps the greatest scientific genius of all









"Page" Jog - forward / backward

Personal Reference History Menu

-  Einstein's Voice
-  Aristotle
-  Black Hole
-  Culminating
-  Galileo
-  Spanish - Gravity
-  Attraction

GENERAL NAVIGATIONAL MENU

-  Available Library
(this CD or Network)
-  Personal Past Travel Maps
(this Library)
-  Table of Contents
(this "book")
-  Index
(this "book")

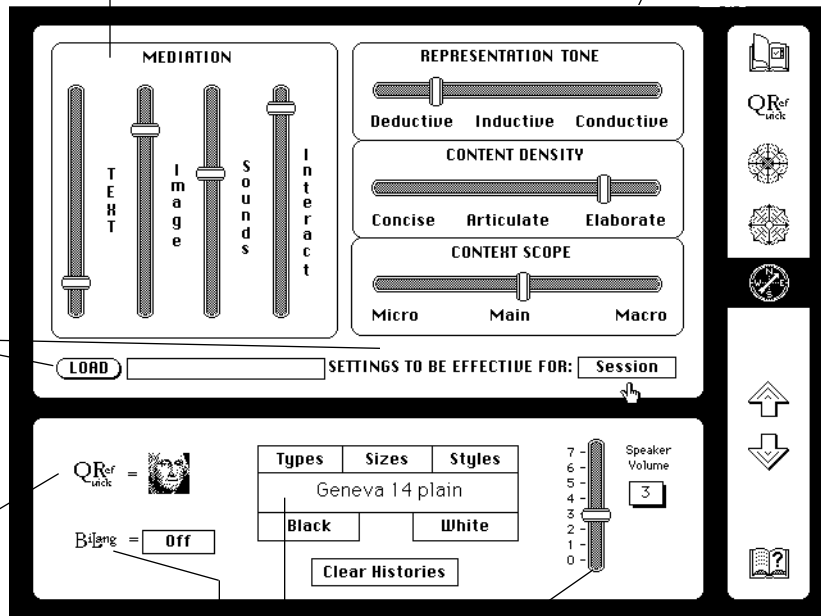


MEDIATION BIAS - LEARNING PREFERENCES - SYSTEM SETTINGS

By selecting the "compass" the learner is enabled to adjust how the interface will present itself and the content it mediates.

Media type settings enable the interface to present representation and reference choices in a menu order reflecting the learners preferences. Content qualities such as tone, density and scope also contribute to the ordering of situational menu choices.

"Load" allows previous settings to be recalled. Another selector allows the learner to indicate the duration of applicability of the settings from "default" to subject specific.



Allows the learner to select a default reference type such that if an element is selected and has a matching reference type, the reference will be displayed or played automatically - 1 step.

Adjust headphone or speaker volume

Character attributes, by type, size and style enables learners to adjust the visual appearance of text to their pleasure or visual needs.

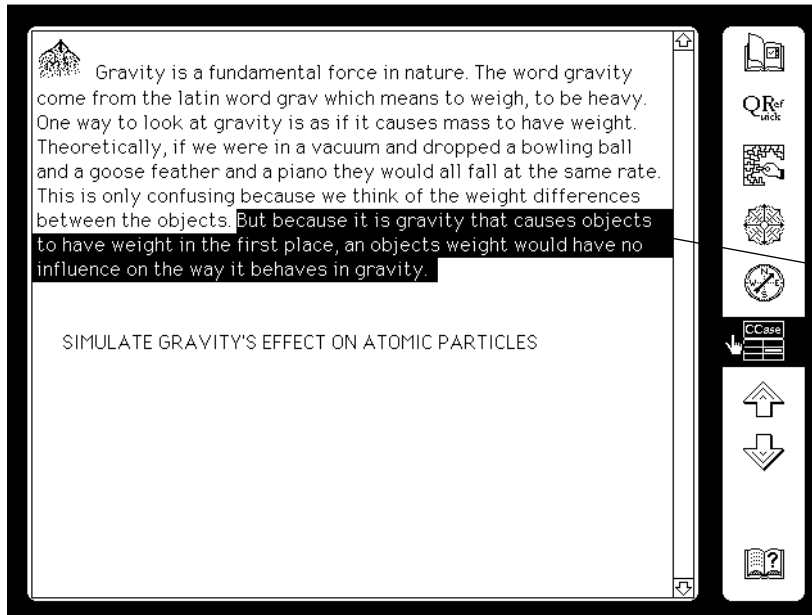


Allows the learner to select a default alternative language type such that should more than 1 alternate language be available the learner needn't be forced to repeatedly choose the one they are working in - 1 step.

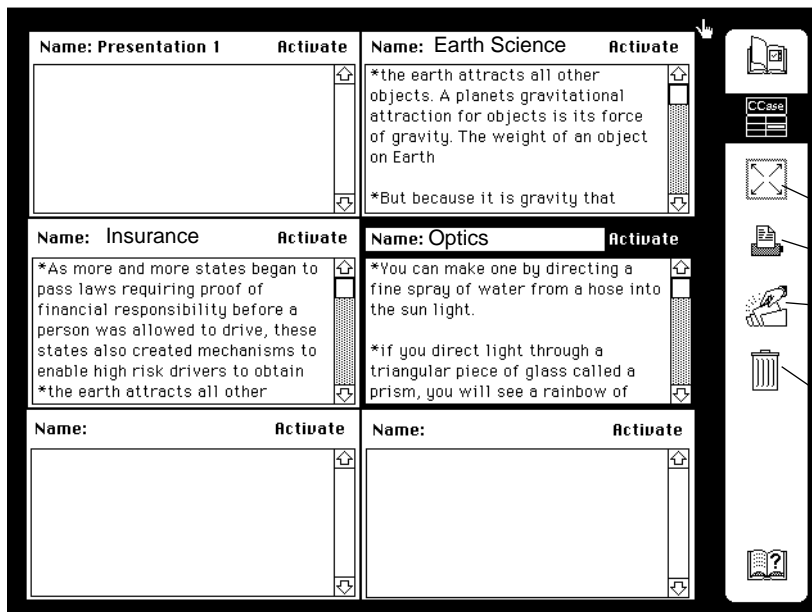
 **COLLECTOR'S CASE**

COLLECT MATERIALS - SORT BY THEME - EDIT & PROCESS

The Learner Interface is provided with a collector's case system that is analogous to having six different colored highlighters in your pocket that store what you highlight in six different reservoirs. At the collector case screen, the learner can assign themes to each reservoir and at the main interface panel a pop up menu allows the learner to select which one he/she wants their currently highlighted materials directed to.



Highlight and direct to case of choice via menu

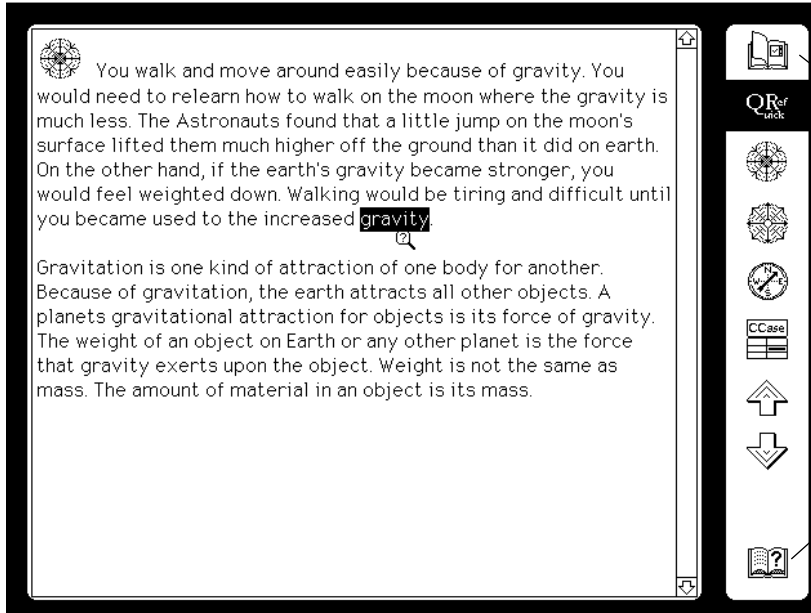


Option - Select to go to six chambered (six colors) Collector's Case

- Expand one and edit/add to it
- Print one or all
- Save to File or paste to Contribute
- Trash

OTHER FUNCTIONS

RESET - SITUATIONAL HELP - TRACKING - TESTING



The screenshot shows a learning interface with a main text area on the left and a sidebar on the right. The text area contains two paragraphs about gravity. The first paragraph discusses how gravity affects movement on the moon versus Earth. The second paragraph defines gravitation and its relationship to mass and weight. A search icon is positioned over the word 'gravity' in the first paragraph. The sidebar contains several icons: a book icon at the top, a 'QR^{ref}' icon, a globe icon, a leaf icon, a clock icon, a 'CCase' icon, an up arrow icon, a down arrow icon, and a book with a question mark icon at the bottom.

RESET - Returns interface to last loaded representation, clearing reference windows or dispatching feedback, contribution or collaboration.

SITUATIONAL HELP - Provides learner assistance with using the system or with the content.



TRACKING (audit trail)

Invisible to the learner every selection they make; library, book, representation, reference, help or testing is transcribed into an audit trail that, along with their other forms of participation, forms the basis for how the teacher and educational system as a whole learns to better serve the learner.

TESTING

Tests or quizzes and self evaluation games can be interspersed throughout the materials as "meaning modules" or as forced external applications.

This is the main display area of the Authoring System. To the right is the Reference Manager. The icons above represent the top level of system controls.

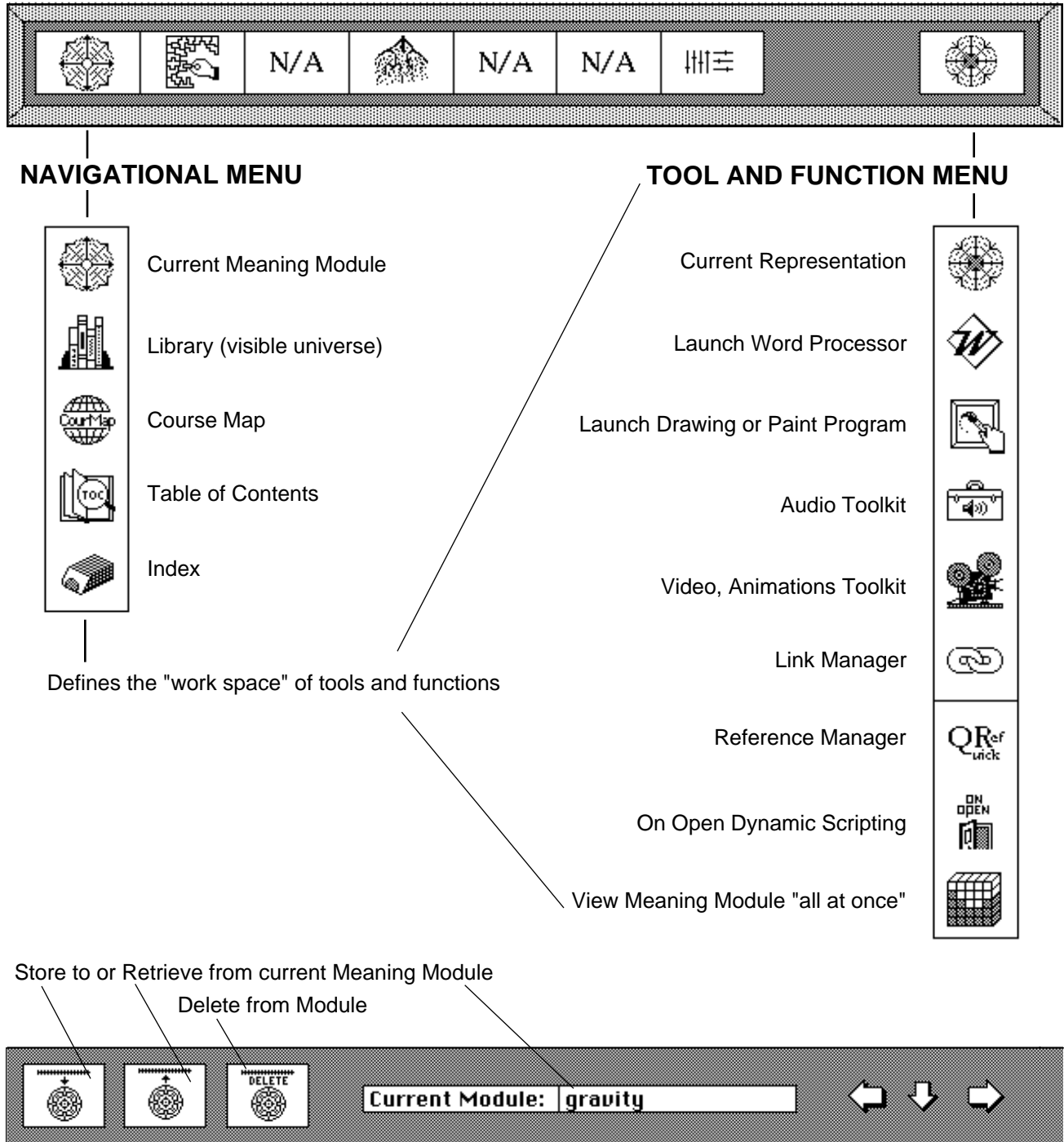
The Authoring System renders transparent virtually all concern for software level file management and content connections (linkages), allowing authors to focus on the orders, contexts and meanings they are articulating. Although the Authoring System can be thought to perform in ways similar to hypertext and multimedia, it is more accurate to describe it as a **"hyper context"** system. In this way it is an interface between curriculum, pedagogy, specific learning objectives and the creation and management of resources related to them.

The system is comprised of a series of tools which will be described on the following pages:

The Reference Manager window shows the word "surcoat" in a search box. Below the search box is a grid of icons representing different resources, with some labeled "in". At the bottom of the Reference Manager are buttons for "Options...", "Actions...", and "Save...". The main display area shows a medieval manuscript illustration. At the bottom of the interface are three blue buttons with circular icons, a "Current Module: Middle Ages" label, and three blue arrow buttons.

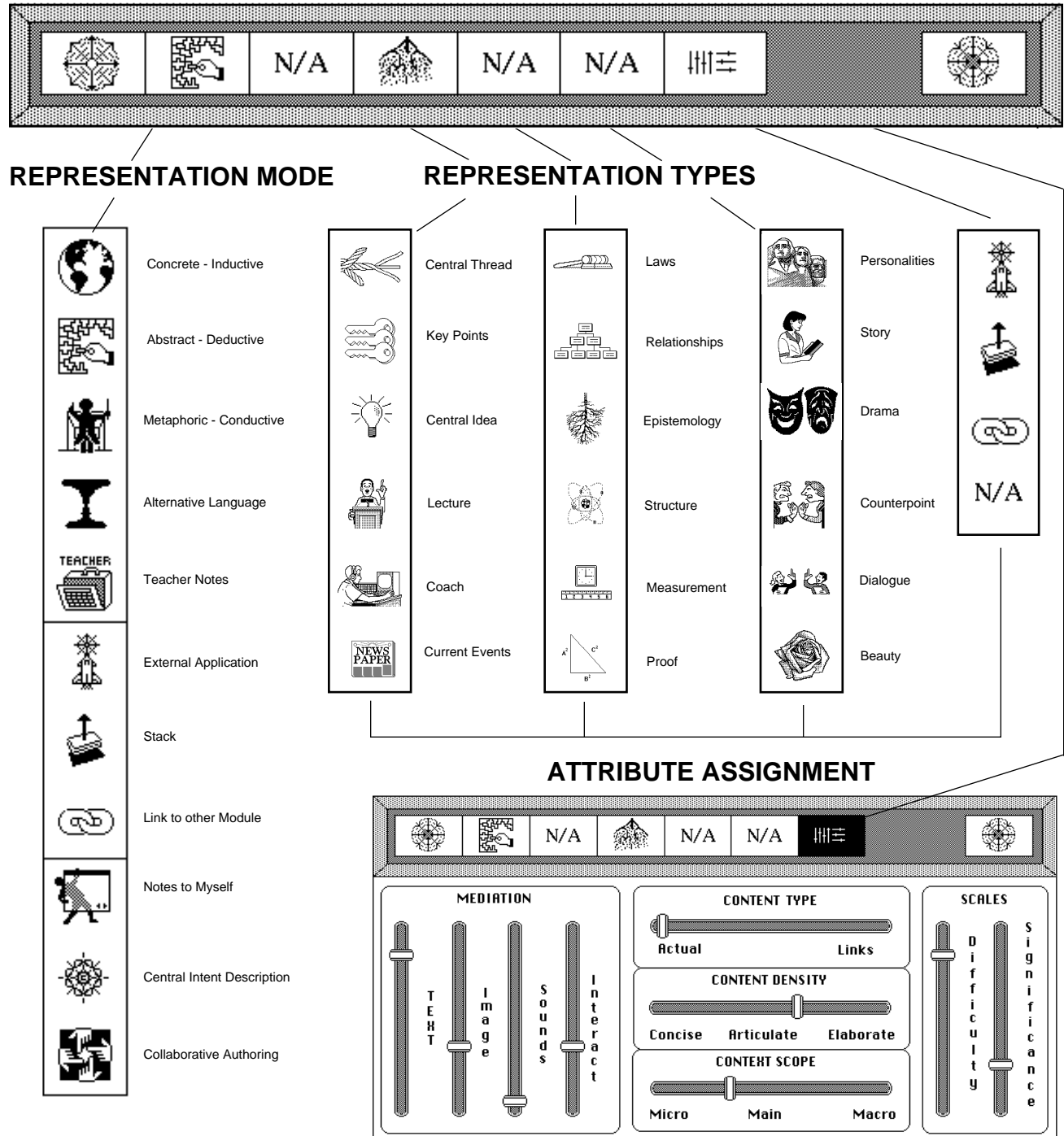
NAVIGATION AND TOOL MENUS

The Navigational Menu provides access to an "outline" like system from which to see the course or book as a whole and to create or open a Meaning Module making it the "context space" or work space for subsequent activities. The Tool menu allows the author to call upon their favorite creativity and productivity tools. The files created or edited by applications launched by the Tool Menu are named and correlated to the current Meaning Module by the Authoring System. (see Development Plan page 3 for more technical detail)



REPRESENTATION AND ATTRIBUTE ASSIGNMENT

Either before or after the creation of content, the authoring system provides the author with the means to identify the MODE of representation, the specific TYPE of representation and whether or not it is an external (application, stack or link). After the content of the representation is completed the author assigns ATTRIBUTES. These processes result in a "tag", a mathematical word, that follows the representation and forms the basis for how the Authoring System's compiler places the representation within a meaning module as well as how the Learner Interface operates on and represents it to the learner. (see Development Plan page 5 for more technical detail)



QRef Wick REFERENCE TOOL WINDOW

At any time during the authoring process the author can highlight a word or phrase (or click on a component of an image) and by depressing a power key bring forth the Reference Tool Window. When the window appears its display indicates what types of (if any) references currently exist for their selection and allows the author to instantly "note" to him or her self, to other team members or to the system (see Reference Manager) that the selection is to be accompanied by references (indicating which types). If the author chooses he or she can use the window to create the reference "on the fly". Options allow the author to link their selection to other previously referenced selections. (see Development Plan page 4 for more technical detail - see Products: Learner Interface page 2 for description of reference icons - see this component's "Reference Manager" for other related information)

The screenshot shows the Reference Tools window overlaid on a text editor. The text editor contains the word "attraction" highlighted. The Reference Tools window has a title bar "Reference Tools" and a search field containing "attraction". Below the search field is a grid of 12 icons representing different reference types. The "INDEX" icon is highlighted. Below the grid are three buttons: "Options...", "Actions...", and "Save...".

- Add selection to index
- Reference already exists
- Need for reference noted
- Actions: Edit or Create, here or jump to Reference Manager
- Options: Refer to other references

This screenshot shows the Reference Tools window for "attraction". Below the grid of icons, there is a recording interface with buttons for "RECORD", "PLAY", "STOP", and "ERASE". It also includes a "RECORD FOR" field set to "4" seconds, a "Sampling Rate" field, and a "LEVEL TEST" meter.

This screenshot shows the Reference Tools window for "gravity". The "GRAVITY" icon in the grid is checked. Below the grid, a preview window shows the text: "GRAVITY: gravitation. Gravitation, or gravity, is a force that attracts all objects in the universe; it is the most familiar of the four FUNDAMENTAL INTERACTIONS of matter. Gravity, which was described quite well by Sir Isaac NEWTON in the 17th century, was the first force to be fairly well understood. In the 20th century, Albert EINSTEIN's theory of general..."

This screenshot shows the Reference Tools window for "Newton". The "INDEX" icon in the grid is checked. Below the grid, a preview window shows a portrait of Isaac Newton.



"ON OPEN" SCRIPTING

The Authoring System makes it easy for authors to "script" how the Learner Interface will perform dynamic functions. Whenever the author would like the opening of a module or representation to cause particular references or other representations to automatically appear (particularly when the reference or representation is an image, a movie, a simulation, test or a sound strip) he or she selects "On Open" from the Tool Menu. This results in the presentation of a simulated Learner Interface and a series of dynamic menus. From these menus author's can select from among all the contents assigned or linked to the current meaning module. By selecting among these simple menus a "script" is created that the Learner Interface will act on whenever the module or representation it is associated with is loaded. (see Development Plan page 6 for more technical detail)

"Interface Situation Menu" enables author to establish how the interface will configure itself when this module or representation is opened

Select from applications or other externals available in or linked to this module. (will auto-situate)

Select from images available in this module (will auto-situate)

Select from iconic menus of representations or references available in this module (will auto-situate)

Select from sounds available in this module (will auto-situate)

AUX SPACE
"Black Hole" movie

1 - Gravity is a fundamental force in nature

2 - The word gravity comes from the latin word grav which means to weigh, to be heavy.

3 - All objects in the universe are attracted to one

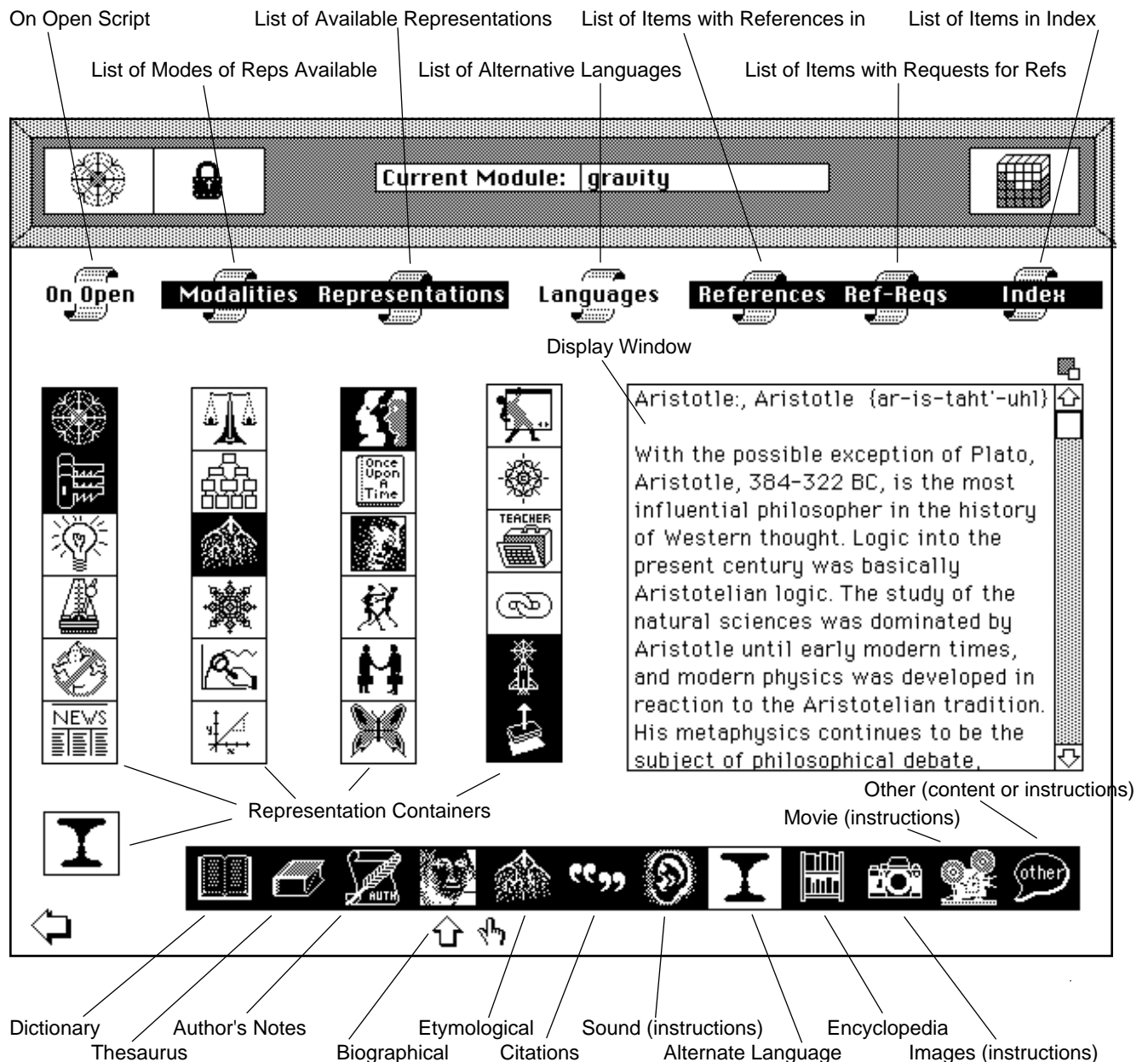
1 - Gravity is a fundamental force in nature

2 - The word gravity comes from the latin word grav which means to weigh, to be heavy. One way to look at gravity is as if it causes mass to have weight. Theoretically, if we were in a

relativity

"All-At-Once" Meaning Module View

At any time during the authoring process the author can select the "all-at-once" view from the TOOL menu. From this window the author can see the distribution of the module's contents including the scripts, lists, representations, references, links and instructions. By selecting a meaning module "cavity" its contents are put into the display window. Though normally locked into a display only mode, a sophisticated author can edit any of the contents of the module through the display window and subsequently reinstall them into the module.



CHANGING THE FACE OF THE INTERFACE

Either by author's control or subsequently by the learner's control, the look & feel and controls (icon family) of the interface can be easily changed.

Some younger learner's may identify with certain cartoon characters such as Disney's Prof. Ludwig Von Drake, for example, and quickly associate his icon with 'scientific thinking'. For older kids Star Trek's 'Spock' or 'Data', or Conan Doyle's 'Sherlock' may have the same association. Girls may adjust the interface to use different color tones and icon families than boys.

Without effecting the underlying authored content, the Learner Interface is designed to allow a variety of such 'overlays' which will change the experience of using the tool. Both the author (who can create and/or call upon such sets) and the learner (within the library of surfaces provided) can change the color and art used as the background for the interface's various windows as well as changing the icon set used in conjunction with a course contents.



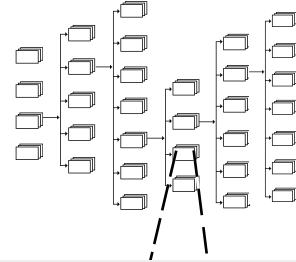
Each of the screens above show a different color, texture and icon set



EPL GENERAL OUTLINES

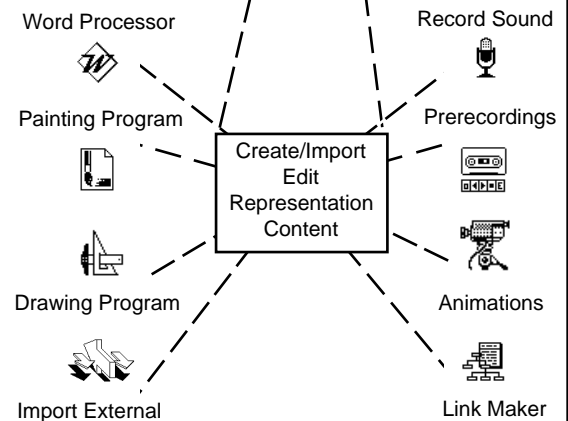
Course/Outline Generator

- Create or edit sub-unit or overall course outline
- Assign names to outline identified meaning modules
- Convert outline into Courmap (system's course content navigator)
- Create Table of Contents

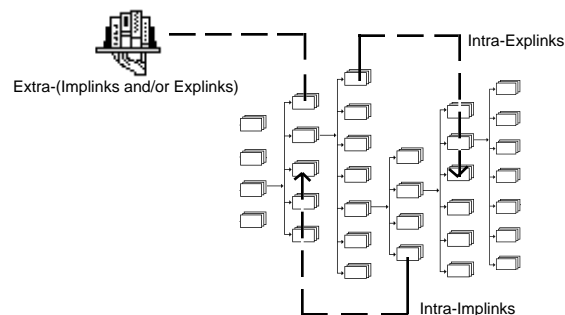


Representation Editor/Generator

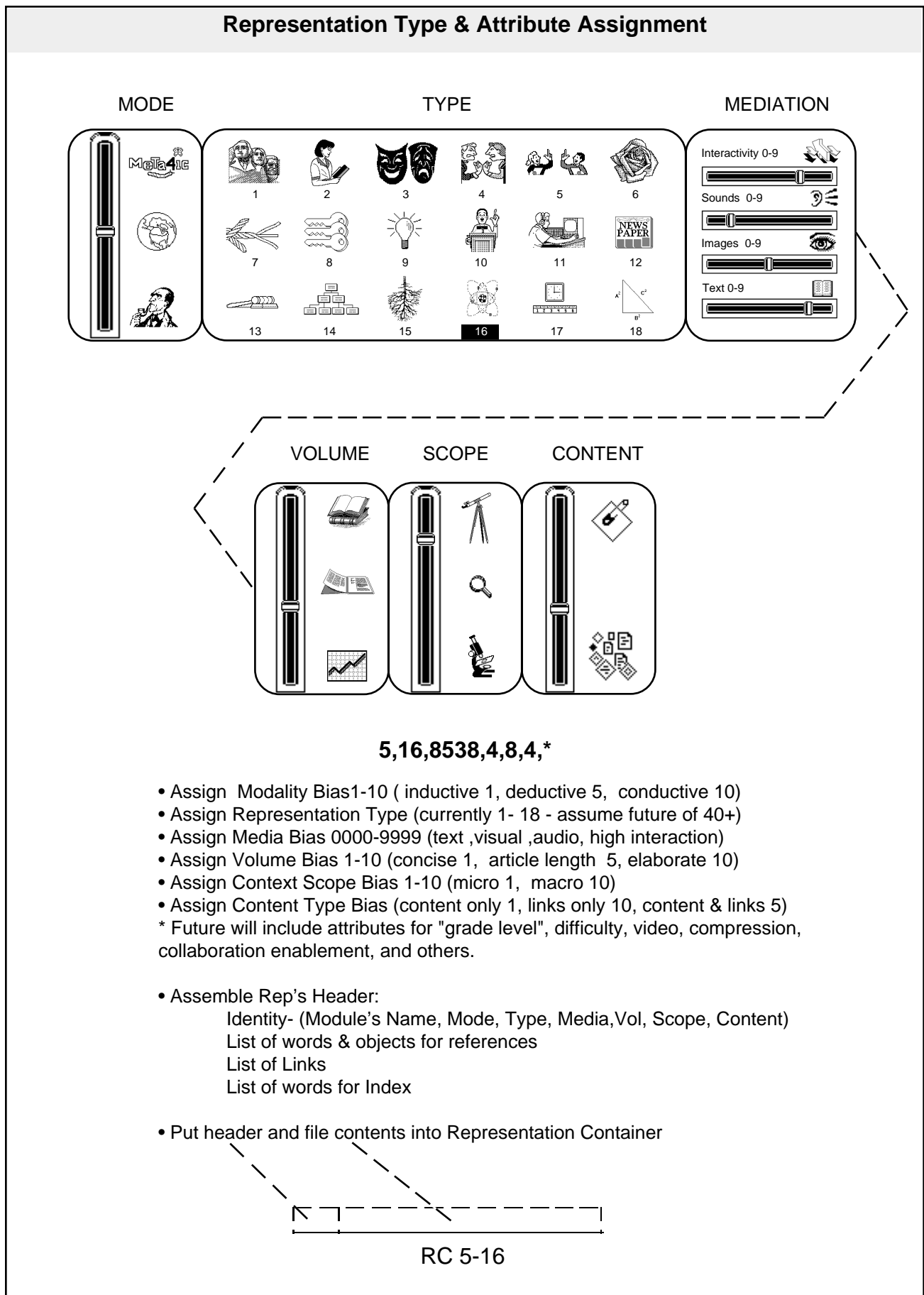
- Identify and select desired module in outline or Courmap
- Select Creator/Importer/Editor/Link Maker Application
- Create/Import/Edit representation content
- Identify Words, Phrases, Sentences or Objects for references (manual)
- Identify Words or Objects for indexing
- If necessary translate file to Interface formats
- Name File to correspond to Module's name
- Append file name with temp sub#
- If Representation is an External add name of External resource required
- Go to Representation Type & Attribute Assignment

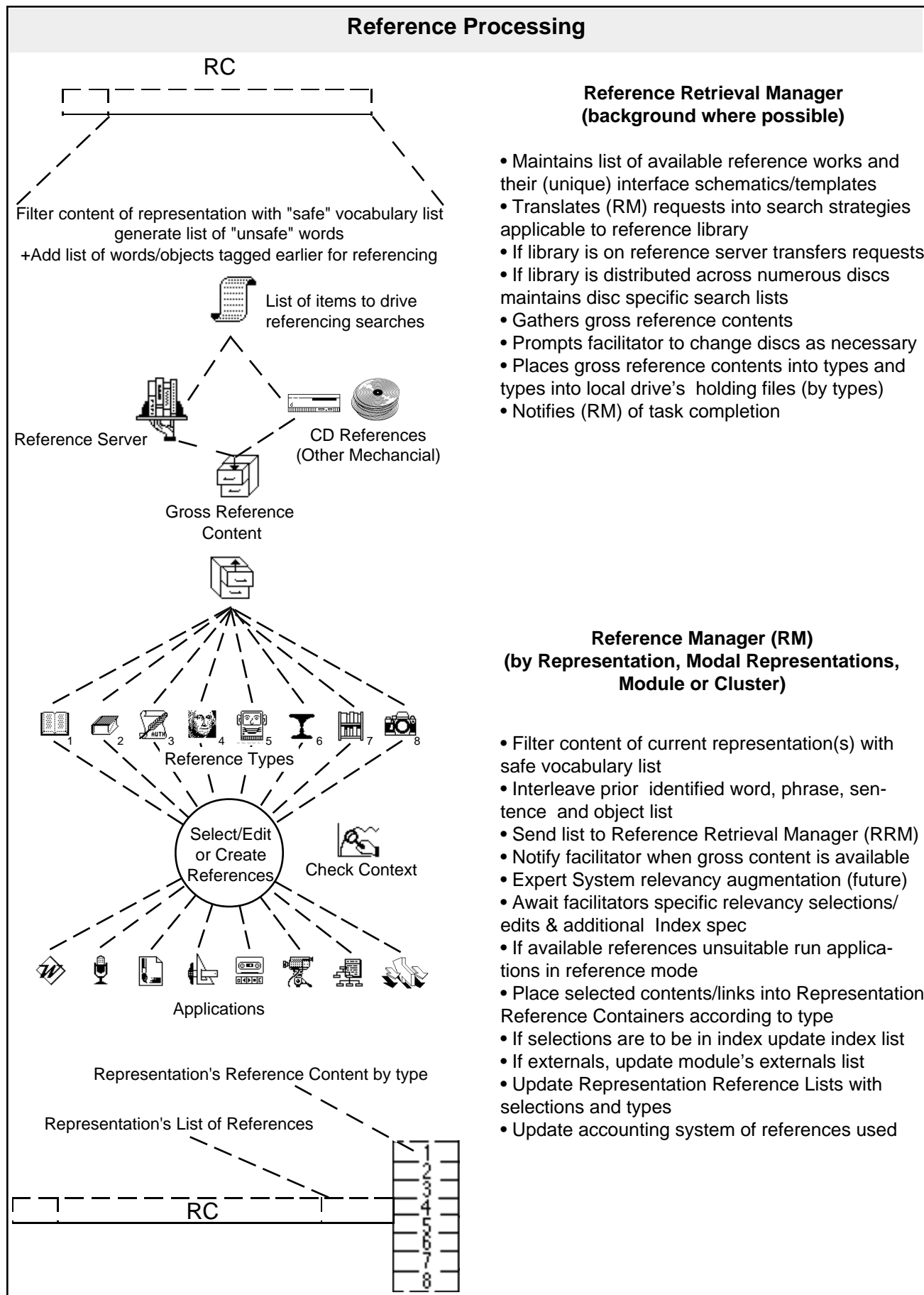


Link Maker - Quiz Maker



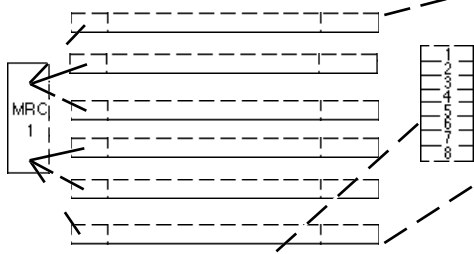
- If Link is IntraCourse select target Module in Outline or Courmap
- If Link is ExtraCourse locate content and select
- Specify IMPLINK or EXPLINK (Implication or Explication links)
- If Quiz select retrace IMPLINKS and associate with responses



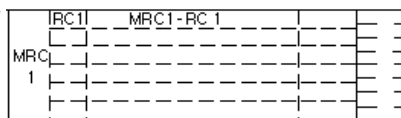


AUTHORING SYSTEM COMPILER SCRIPT OUTLINES

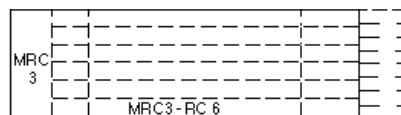
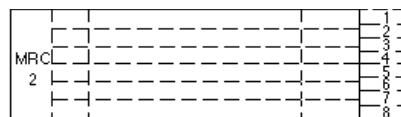
Gather Representations with same name and "mode"
 Read Representations' headers and summarize in Modal Representation Container's header



Compile Modal Representation Container (MRC)



Gather MRCs with same name



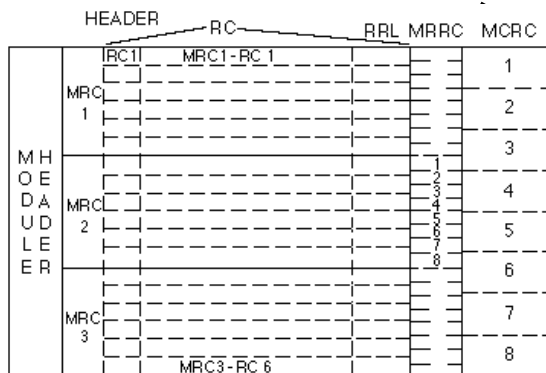
Consolidate Representations' references into common Modal Representation Reference Containers (MRRC)

Module Compiler

- Assign module id# put it into header
- Put module's name into header
- Place available Representation Containers (RC) into (MRCs)
- Create (MRC) Headers
- Compile Available Representations List - put into header
- Compile module's index list
- Put CourseLinks list (Clinks) into header
- Compile module's Implinks list
- Compile module's Explinks list
- Eliminate reference content redundancy within Modal Representation Reference Containers by consolidating common reference content into Module Common Reference Containers by type
- Send Module to Course Compiler

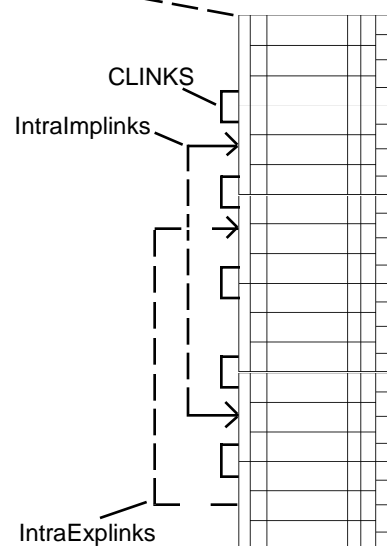
Read MRCs headers and summarize in Module's Header

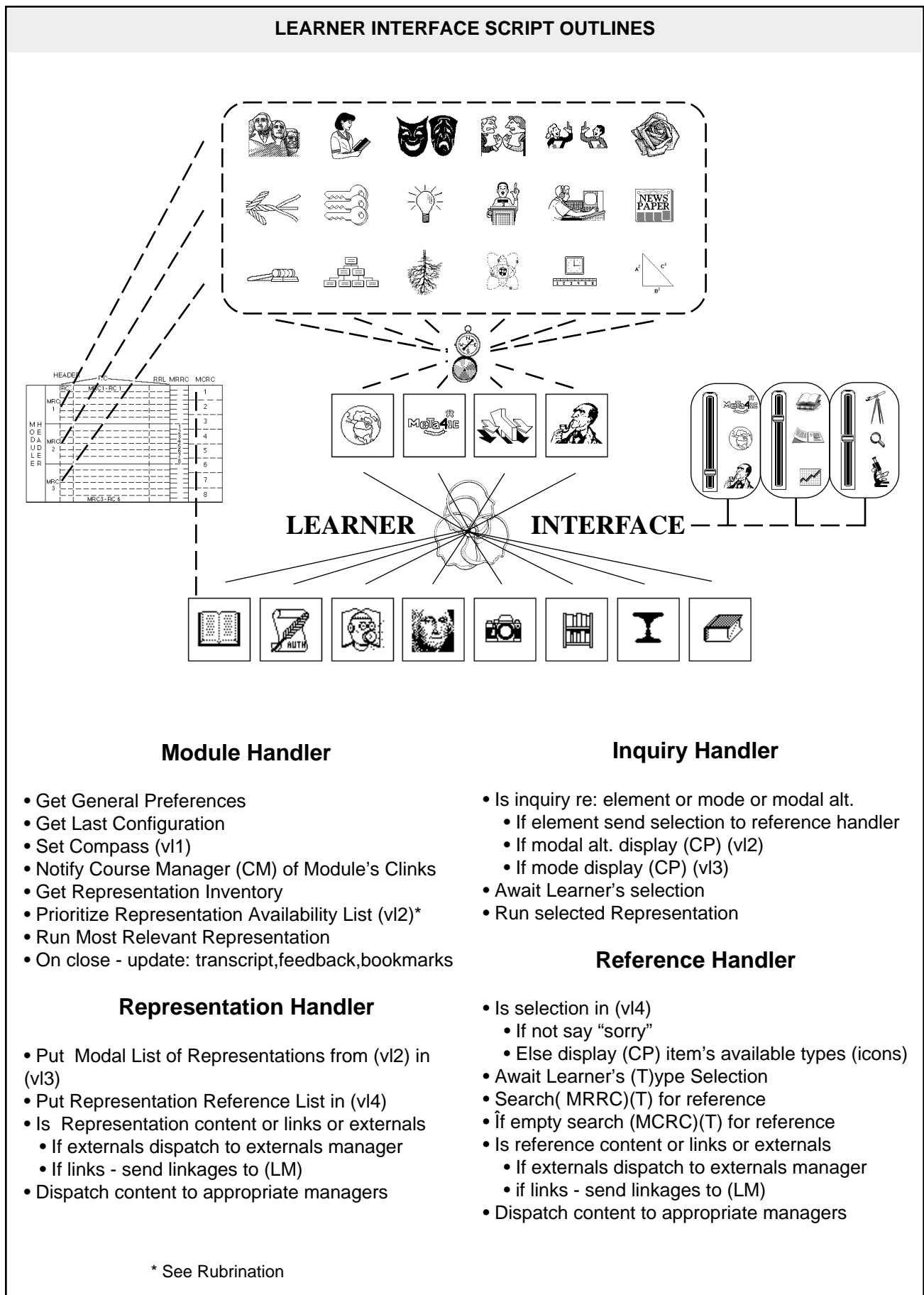
Remove redundancy in MRRCs by placing common reference contents into Module Common Reference Containers (MCRC)



Course Compiler

- Check Courmap for Module's location within Course
- Update Courmap with Module's Header
- Check Intra Course Link File for Implinks or Explinks otherwise unrepresented in module
- Update Module header to reflect links (if any) and recompile as needed
- Reduce redundancy - Redistribute MCRC content into Cluster Reference Container (future)
- Update Intra Course Link File with module's links
- Update/verify TOC handler of Module's name
- Update Course Index with Module's Index
- Compress module (future)
- Place module into course space according to Courmap
- Verify Clinks





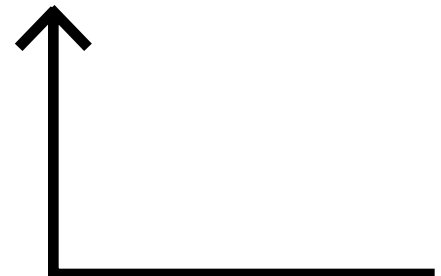
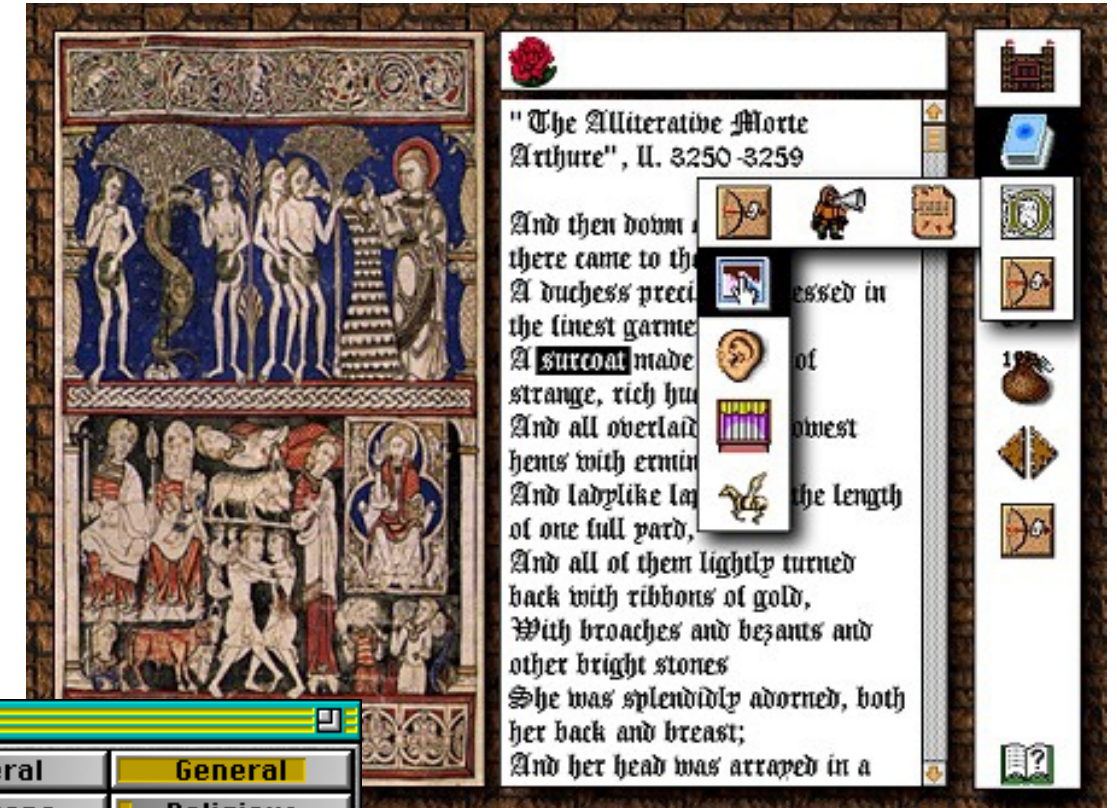
Authoring Tool



THE EPL LEARNING LOOP

The Authoring Tool creates contents that “run” on the Learner Interface. When learners have unmet ‘meaning needs’ a dialog box enables them to inform the system of what they need (or at least where they are that isn’t meeting their needs). The feedback flows to the Visualizer which enables the teachers, instructional designers and curriculum content providers to see the actual aggregate patterns of needs within their learning constituency and adjust and extend their contents accordingly.

Learner Interface



This is the EPL Feedback Visualizer (US patent 5537618 & 5566291). To those persons who are directly responsible for an aspect or component of a “learning objective” (or others interested in learning about such a person’s “space”), the Visualizer represents the equivalent of a radar system that can “zoom” through “views” ranging from the “orbital” to the “sidewalk”. Enabling them to see and respond to the patterns or specific messages of their “virtual constituents”, the EPL Visualizer is designed to make processing and learning from feedback messages (from dozens to millions) as powerful and simple as possible.

General	General	General	General
Question	Never/FYI	Everyone	Religious
Idea	No Hurry	Experts	Political
Problem	Soon	Not my Prof	Artistic
Complaint	Im Stopped	Anonymous	Scientific

What When Who Orientation

By Day 1/12/95

Monday Friday

Sept Feb

9 3

1994 1995

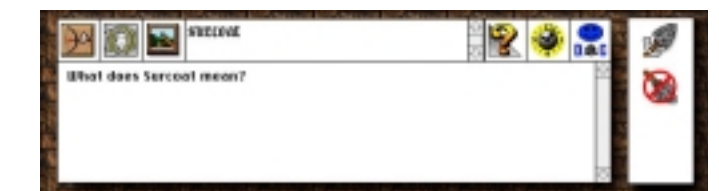
Question Soon Everyone Artistic

Eng Lit:Middle Ages:Chaucer:The Alliterative Morte 1/12/95

What does Surcoat mean?

THE EPL FEEDBACK VISUALIZER

Review Context Authoring Tool Respond Delete



The Learner Interface's Feedback Dialog



The image to your right illustrates seven of the Visualizer's component sub-systems. The top right sub-system (1) allows a user to navigate among the selectable "locations" they are responsible for or authorized to explore. Assisting the user in navigating are the numbers appearing to the right of each location. These numbers reflect the count of messages received by the system at each location and as conditioned by all other currently selected filters (situations and time). Selecting an area for inquiry, every other sub-system (category, situations, time and the filtered group list) readjusts to reflect the distribution of messages at the newly selected location. The same process applies to navigating and selecting among the categories and sub-categories (more detailed locations) available in the next sub-system (2). **In effect, these two sub-systems enable a user to focus where they want to learn within the domain of their responsibility or authority (example: show me all messages about *English Lit*, regarding *Vocabulary Concerns*)**

Sub-system (3) displays the categories of attributes (WHAT, WHEN etc.) and the specific attributes (Question, FYI etc.) that are associated with the system as a whole or more specifically to a selected location, category or sub-category. The colored bar overlaid on top of each attribute (Question, Idea etc.) indicates the percentage of the messages currently selected (by location, category, sub category or time) that share this attribute (for example the % of questions about Vocabulary). A glance across the array of attribute indicators reveals the overall distribution pattern of all categories and attributes at once. Each attribute is also a button that upon selection filters all the feedback messages in the scope of previous selections by that attribute (for example, selecting "problem" would reduce the number of messages in all locations and times to the number of messages that are problems). **In effect, this sub-system enables the user to see and select patterns of feedback as they distribute across the attributes associated with the location of their inquiry. (Example continued: Show me all *questions* about *English Lit*, regarding *Vocabulary*, that that request I respond *ASAP*..)**

Sub-system (4) displays the distribution over time of the selected feedback messages. The sub-system's main window displays and allows selection of the feedback messages across a scope of time whose "units", the vertical bars, can be set to: minutes, hours, days, weeks, months, quarters or years and whose vertical height indicates the relative distribution of the quantity of selected messages across time. Additionally, the window's parameters can be set to "scopes" including: today, this week, last week, this month, last month, this quarter, last quarter, this year and last year. The "slider" allows the user to move the window across the scope selected and center it over the time span of their inquiry. Selections can be made to any number of units in any combination of contiguous or discontinuous groupings. Selections result in all other sub-systems of the Visualizer being updated to reflect the messages that occurred only in the selected time units. **In effect, this sub-system enables the user to see and select patterns of feedback messages as they distribute across the time span of their inquiry. (Example continued: Show me all *questions* about *English Lit*, regarding *Vocabulary*, that that request I respond *ASAP*..) and that were sent on January 12, 1995...**

NOTE: Although all of the sub-systems described so far interactively and collectively sift the messages being processed, each sub-system works independently of the others and no order or sequence of "focusing" is imposed by the system. A user is free to follow any inquiry thread that suggests itself during their use of the tool.

Sub-system (5) displays the filtered list of feedback messages according to the overall selections made in sub-systems (1- 4). The header display of each feedback message can be arranged to further reflect the user's preferences (who sent the message, which department, class or school it came from, the date it was created, the situation or urgency level, etc.). The user may scroll through the list and select a particular feedback message to examine (read, hear or watch). **In effect, this sub-system enables the user to see and select from a list of feedback messages that matches their criteria of search. (Example continued: Show me all *questions* about *English Lit*, regarding *Vocabulary*, that that request I respond *ASAP*..) and that were sent on January 12, 1995 and order the list by *urgency*.)**

Sub-system (6) displays the actual content of feedback messages selected in the list box of sub-system (5), this will later include "playing" voice and video feedback messages. Above the feedback content display window are a series of "heads up" indicators that display once again the location, category, sub-category(s), date (and/or time) and the specifically selected attributes (Question, Soon, Experts, etc.) of the particular message being reviewed. This sub-system is also used to display "top feedback" lists and the distribution of "reinforcements" to the items on it (not shown in the illustration). **In effect, this sub-system enables the user to read the actual content of any individual feedback message sent by a user.**

Sub-system (7) consists of four buttons which enable the following functions: 1) Review Context - this button launches the LEARNER INTERFACE and automatically sets it to simulate the actual condition or situation it was in when the user sent the feedback. 2) Authoring Tool - this button launches the authoring tool and causes it open the 'course/module' at the location the feedback is in reference to and allows the user (if authorized) to adjust or edit the content. 3) Respond - this button launches a mail system interface and passes to it the feedback sender's mail address. This enables the Visualizer owner to respond by note or attachment if appropriate or necessary. 4) Delete - this button deletes (if authorized) or merely masks from a particular user's view the feedback message currently under review.

In effect, this sub-system enables users to take a variety of actions including: helping them better understand the perspective of the message sender, changing the feedback capture configuration (menus and icons) that user's see at this location, sending a return message (and if desired, an accompanying attachment) and deleting a message.

In addition to the sub-systems shown and discussed, the Visualizer can be set to "scan" for "out-of-range" patterns in areas of recurring interest to its user. It can also be made to generate printed reports and/or output formatted files that could be subsequently processed by other analytical tools including common spreadsheet applications.