2002 ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities
Davos, Switzerland
Editors: Jack R. Lohmann and Michael L. Corradini

Year 2004 *Paper* 11

The Future of Learning Objects

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e-Technologies in Engineering Education Learning Outcomes Providing Future Possibilities

The Future of Learning Objects

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Abstract

Learning objects are fundamental elements of a new conceptual model for content creation and distribution. They are destined to change the shape and form of learning, ushering in unprecedented efficiency of content design, development, and delivery. Their most significant promise is to increase and improve the effectiveness of learning and human performance. This paper speculates on the future of learning objects, and describes how the content model for learning objects fit within this larger vision of the future of learning. It poses some provocative yet pragmatic points to ponder, and hopes to stimulate new thinking and ideas

I. Introduction: A Vision for the Future of Learning

The most powerful promise information technology offers is its ability to capture knowledge so that it can be analyzed, reused, shared with others, and used to create new knowledge. The impact of just-right information flowing to the right place, person and time, cannot be overstated. The significance of this shift in thinking is so profound that it is difficult to imagine its impact without the use of metaphors and analogies. One way to consider the profound impact that this new model of learning will have on pedagogy and best practices is to think of our need for learning less as cognitive accomplishment and more analogous to our need for nourishment. When we recognize that learning, like hunger, is not a problem requiring a solution but a condition to be continually addressed, it is easier to imagine extending our range of flexibility to meet situationally specific needs.

Just as we decide what, where when and how to eat, (fast food or family feast? crystal glasses or plastic cups?) we will be able to discover and obtain the learning we need that suits situationally specific needs. Just as today we can go to a store to secure ingredients for preparing meals, and stores are carefully managed to meet the predictable demands of their customers, so in the future will we be able to secure objects for learning as our needs arise, based on the predictability of those needs as determined from our past learning behavior.

A UNITED ENGINEERING FOUNDATION CONFERENCE
Davos, Switzerland 11-16 August 2002
http://www.coe.gatech.edu/eTEE

II. My Lego™ Epiphany

My journey into this world of learning objects started with an "epiphany moment" watching my children play with LEGO ™ blocks many years ago. As with most families, my son and daughter have very different learning preferences. One preferred instructions, directions and a pre-determined end state (a castle as I recall), and the other preferred complete freedom and creativity of constructing things (a robot in this case). As it struck me that both had their wonderfully different needs met equally well with these simple blocks of plastic, I began what has been more than ten years of refining a dream of a world where all "content" exists at just the right and lowest possible size, much like the individual blocks that make up LEGO ™ systems. In this dream, these "prime sized" blocks of content have a fundamental "standard," the equivalent of the "pin size" of the LEGO ™ blocks, such that they can be assembled into literally any shape, size, and function. Some people may find the most value in taking a pre-assembled unit and putting it to direct use. Others will want to assemble their own, possibly from scratch, but more likely from sub-assemblies. Some will want instructions and guidance on how to assemble the blocks, while others will want to determine their own results. However they may be used and applied, the empowerment of literally every individual by such a world full of learning objects is staggering.

III. In Search of a More Powerful Analogy

While useful in its simplicity, the Lego™ example belies the much richer and complex nature of the overall content model needed to show the relationships between and among content elements of varying complexity. The construction or building industry may provide a much more robust analogy. On average, 85 to 95% of the total amount of materials in every building built in the past ten years, be it commercial or residential, are pre-built components. Things like doors, windows, cupboards, sinks, ceiling tiles, light fixtures are all manufactured to meet specific standard dimensions and attributes. This means that almost all of the material in any building is pre-manufactured and sitting in a warehouse awaiting delivery BEFORE the building is conceptualized, designed, or built.

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In many respects, creating a new building is really a complex "assembly" project. In spite of almost all the materials being pre-existing standard-based components, the process of conceptualizing and designing a structure offers tremendous opportunities for creativity and innovation resulting in unique new buildings. These same component "building objects" can also create dull, uninspired, "cookie-cutter" housing or office buildings.This underscores the importance of architects, designers, engineers, plumbers, electricians, artists, craftspeople and customers. Objects, like building components, enable enormous creativity. However, their effective use demands careful conceptualization, specification, selection and assembly.

The more one considers the comparison between the building industry and the emerging content object economy, the more apparent are the parallels. For example, standards such as building codes are necessary to ensure a minimal level of safety, functionality and quality. Standards determine that electrical outlets in bathrooms or other wet places minimize the likelihood of accidental electrocution. It is quite clear that strict enforcement of building codes has little or no effect on the overall conceptual design of buildings. Conforming to standards does NOT mean that there will be nothing but standard buildings that all look the same. Similarly, having a great and ready supply of components does NOT produce products or results. Having all components conform to standards so they are fully interoperable or exchangeable does not mean that they magically can or will assemble themselves.

This component-oriented, object-based model provides the conceptual framework for creating economies of scale. It is largely because of the shift to component-based building construction that occupying a home does not require having to build it oneself, that we can have the volume of buildings we do, that they can be constructed quickly and that they are as affordable as they are. A similar picture for content is emerging: an object based paradigm, supporting standards, supply chains of specialized components and professions, project based models, and so on. While there is certainly still MUCH room for improvement with all of these points, the path ahead for content bears remarkable resemblance to the building industry. By using this familiar and relatively mature model as a reference, we can learn from it and accelerate the time it takes for the content equivalent of this model to be created, implemented and improved.

Just as we have seen the approach to buildings evolve from a craft-based approach to its current highly component based model, we will see the overall approach to content go through a similar revolution, and in a much shorter time. We will see whole new networks and channels of suppliers and specialty trades emerge as businesses in themselves. The equivalent of door, window and lighting manufacturers and the complete collection of diverse "trades" of skilled workers will grow and evolve.

IV. From Vision to Strategy

A. Autodesk, Inc.'s Content Model

Autodesk, Inc. has conceptualized a unique version of this model to create a content strategy based on reusable information and learning objects. This strategy consists of:

- a common component based approach;
- structured content based on a common hierarchical data model;
- metadata at each level of the content hierarchy;
- a process methodology; and
- a technical infrastructure for developing, assembling and managing reusable granular content objects that are written independent of delivery media and accessed dynamically through a database.

The end result is database managed repositories of reusable information objects and metadata that can be used for all forms of learning and media delivery types. These include e-learning, traditional instructor-led training, or blended learning solutions and media delivery types such as print, interactive CD's and web venues. It is worth noting that this same common content model is now being applied across many other content domains including, though not limited to, such areas as product support, technical publications, marketing, and localization. At Autodesk Inc. this is being encapsulated as an enterprise wide "community of practice" and the development of an evolving corporate content strategy. Even more powerfully, this truly "enterprise wide" model extends all the way from employees through partners and channels such as re-sellers, training centers, consultants developers and most importantly to the millions of Autodesk customers.

B. Multi Level Content Hierarchy

The standard Autodesk structure defines a five level content hierarchy as shown in Figure 1. Note that this generic hierarchy applies to multiple applications and that the first two levels are the same for all (enterprise wide) and then become specific to "application profiles" such as learning, for the three thereafter.

- **Data or Raw Media Elements** are the smallest level in this model and consist of the "raw media" stored at a pure data level. Examples include a single sentence or paragraph, illustration, animation, and so on.
- The second level of **Information Objects** is formed by a set of these data elements to create a granular, reusable chunk of information that is media independent.
- Based on a **single** (enabling) objective, Information Objects are then selected and assembled into the third level of **Application Specific Objects**. This is the level in the hierarchy for one of the most common types in

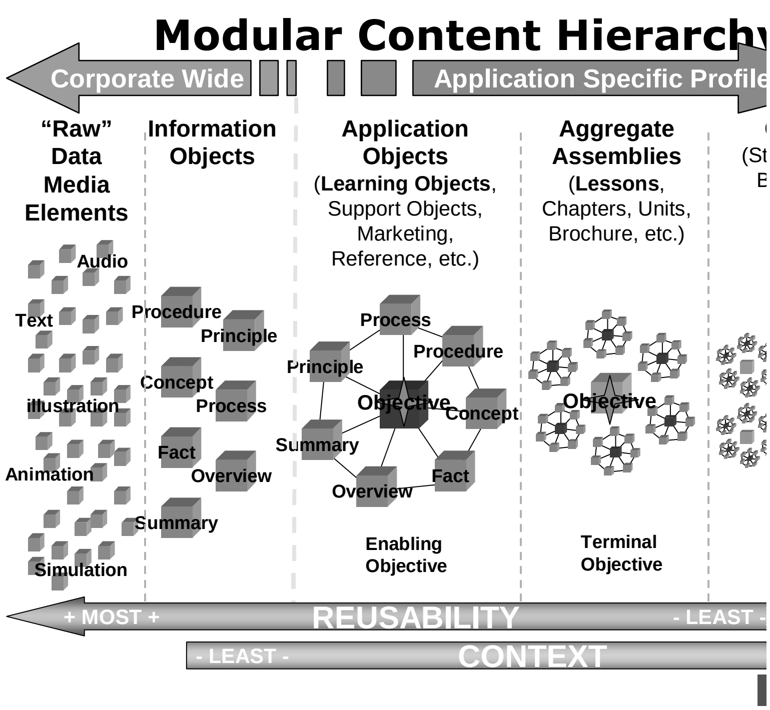

Figure 1. Autodesk Content Hierarchy 1.

- Based on a **single** (enabling) objective, Information Objects are then selected and assembled into the third level of **Application Specific Objects**. This is the level in the hierarchy for one of the most common types in As defined by a modified version of information mapping, each Information Object can stand-alone and is classified as either being a Concept, Fact, Process, Principle, Command Reference, Exercise or Procedure. These individual Information Objects can be combined to form a larger structure called a Reusable Learning Object (RLO). The RLO is a collection RIOs that are grouped together to teach a common job task on a single (enabling) learning objective. Learning content managers combine RLO's to form larger learning structures, such as "Lessons" and "Courses" that are based on specified topic areas (strands), job functions or other business needs to achieve terminal objectives.

V. More New Frontiers

A. Technology that "Learns"

As this object-oriented vision of the future develops, it leads to tools and technology that truly have the ability to learn. Learning **about** technology is important. Technology **for** learning enables amazing results and advances. However, technology that ***can*** learn is going to provide the most revolutionary and significant change. Imagine tools, technologies, environments, data sets, that get better the more you use them, that learn about you and adapt and improve as a result of your interactions and use. Imagine intelligent technological agents and tutors. Imagine these not only aiding learners directly but also augmenting the abilities of real (human) instructors and coaches. Think about being able to create new knowledge based on capturing observed patterns, recognizing behaviors, gleaning and understanding the context of events and actions. Imagine having your ideal mentor available every minute, supplying you with ideas, suggestions, true information, at just the right time, without having to ask for it.

B. Discovery vs. Invention

It is important to distinguish the difference between invention and discovery. Invention, is the creation of something completely new, be it an idea or a device. Discovery is when we first "see" something new to us. This also happens when we figure something out that has been there all along. I believe we are on the verge of grand discovery in the areas of learning, content, knowledge, and objects. Concurrent or synchronistic arrival at similar conclusions by independent groups and individuals who are formulating similar theories, asking similar questions is a harbinger of great things to come.

Just as revolutionary as our discovery of the atomic and molecular models will be our discovery of the equivalent of the periodic table for all content or data. Mendeleyev's 1870s

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creation of the periodic table laid out the basic building blocks of all physical matter and revolutionized our view of that world. Similarly, an equivalent understanding of our data and informational world will give us a fundamental understanding and ability to manipulate, create, and build any substance possible. In the case of data, this model will be based on the ability to take everything down to fundamental elements, understanding their basic structural makeup and components, the equivalents of their electrons, neutrons, protons that combine to form compounds. This understanding will be similarly simple and equally powerful. It will provide some of the basic "rules" that govern what can be combined and how, natural pairings and groupings, nesting structures, and so on.

This "periodic table" will help us understand these natural groupings just as the table of the elements shows us the natural occurrence of minerals and chemicals. It will allow for a literally infinite number of new discoveries as we experiment with new combinations to create the informational equivalents of aluminum and nylon, the wonders of chemical reactions and the inventions stimulated by this new understanding.

VI. Entering the Information Age and the Knowledge Economy...FINALLY!

The ability to capture knowledge such that it can be analyzed, reused, and shared with others, thus developing a spiral of more new knowledge creation, is perhaps the most powerful promise information technology can provide. The impact on learning when just-right information is flowing to the right place, person, and time cannot be overstated.

These changes and discoveries have obvious synergies and relationships that begin to jump-start the Knowledge Age. As this occurs, we will witness a level of revolution equivalent to the agrarian or industrial revolutions in the form of knowledge revolutions and information automation. As with previous revolutionary creations, we will realize order of magnitude increases in productivity and performance, but in the information revolution these will be increased productivity of knowledge and service workers. This is not to be confused with merely generative processing of information, just as the factories of the industrial revolution were not merely the automation of previous process and practice. This will involve the invention of entirely new process for tacit knowledge capture, converting raw data into useful information and the subsequent creation of new knowledge in an ever-spiraling crescendo.

VII. Planning Backwards from the Future

How might we better understand and plan for the arrival of such a future? I suggest that the most practical strategy for claiming the potential riches offered by the information revolution, and avoiding its very real perils, is to "plan backwards from the future." It begins by envisioning the future we want and figuring out how to get there. Inventing the future is not a new suggestion; however, the important difference is the second step in the planning process. Rather than going back to the present and figuring out the next step from there, planning backwards would require us to imagine what the step immediately before arriving at the future would be. Then we imagine what would be required of the stage just before that, and so on, until we get back to the present. Having laid out some elements of the future state of learning objects in the preceding text, we can follow this planning backwards model to look at what would be required immediately before arriving at the future state. For example, imaging this future world filled with literally millions of small granular data objects, selecting a "just right" set, and assembling these into a learning object, would require a rich set of information about each of these data objects. These attributes, or "metadata" as they are properly called, would be required in order to know which ones to select to match up with each person and situation. Similarly, we would quickly conclude that the interoperability, flexibility, and reusability of learning objects could only take place if there were a set of fundamental standards universally in place for this to work.

A. Standards

Widely adopted, open, and accredited standards are a fundamental requirement. History has clearly shown that revolutionary changes do not "take off" without widespread adoption of common standards. In the case of electricity, this was the standardization of voltage and plugs; for railroads, the standard gauge of the tracks; and for the Internet, the common standards of TCP/IP, HTTP, and HTML. Common standards for metadata, learning objects, and learning architecture are mandatory for the similar success of the knowledge economy and future. Fortunately, the work to create such standards for learning objects and related domains has been going on around the world for the past few years. This includes the creation of accredited standards from the IEEE Learning Technology Standards Committee (LTSC) for such areas as Learning Object Metadata, Computer Managed Instruction, Course Sequencing, Learner Profiles, and many more.

B. The Magic of Metadata

Metadata will be derived that can adequately describe every piece of data, every object, every event, and every person in the world. Objective metadata, most of which can be generated automatically, describe physical attributes, date, author, operational requirements, costs, identification numbers, and ownership and so on. Subjective metadata are the more varied and valuable attributes of a learning object, and are determined by the person or group who creates the metadata. The label on a can of tomato sauce provides objective metadata; your opinion of whether that tomato sauce worked well as an ingredient in your favorite recipe is an instance of subjective metadata. It is especially the subjective attributes or metadata that create the ability to capture what is otherwise tacit knowledge, context, perspectives, and opinions.

C. Unlimited and Limited Metadata

As we continue to plan backward by imagining what has to happen before all this is possible, we come to realize that another critical characteristic of metadata is the ability to have any number of metadata records for any single information or learning object. This is particularly obvious for the subjective metadata as they capture such things as opinions, and there is any number of these available and desirable for any single object.

However, we also come to realize the need to understand the limits of metadata and not try to have them capture too much. For example, information about sequencing of learning objects and the creation of learning paths is extremely important for the effective use of learning objects. These attributes are not describing the content itself, but rather the use of the content, and are therefore not part of the metadata, but rather the application of the learning object to a specific use and objective.
As personalization becomes the key element of learning, subjective metadata become increasingly important. The value of the learning object goes up as its associated metadata increase in richness and completeness. The value of the data objects also goes up as it approaches its smallest potentially useful size.

D. Capturing Experience

When technology is able to capture and learn from its own experience and from its user, it gains a critical new power: accurate prediction of what will be needed next, in terms of information it can provide or suggestions it can offer. This is possible through the analysis of the experiential knowledge that has been collected, and it creates new knowledge in the form of patterns and profiles. It has often been overlooked that just-in-time learning and performance support are only possible with this predictability. With it, learning is truly as adaptive as the technology itself.

E. Profiling Learners

Personalization of the learning experience requires knowing something about the learner. To avoid redundancy, the system must know what the learner already knows. To assemble relevant learning experiences, it must know about the learner's past experiences, learning preferences, career goals, and more. Personal profiling enables new approaches to productivity. A profiling system that automatically identifies people's areas of expertise based on the issues they research on the Internet, the ideas in their documents, the e-mail messages they create, and the topics they follow in their knowledge bases facilitates creation of virtual workgroups, encourages communication, and reduces duplication of effort.

The more a learning system knows about a learner, the greater the opportunity to provide on-target information. At the same time, one's learning record should be at least as secure as one's credit record and medical record. Thus, security and trust become critical attributes of this future.

VIII. Strategies for Success

These three strategies appear to be the keys to determining learning object success both currently and in the future.

A. Make It Relevant, Make It Easy

For learning objects to be widely adopted prospective learners must be able to see their fundamentally high value. Learning objects will need to be conceptualized, designed, constructed, selected and used quickly and easily. This should NOT be confused with the underlying complexity that is required to make all this work and make it work transparently. Indeed, there is likely an inverse relationship between the external simplicity and ease of use of any technology or system, and the underlying complexity required to make it happen. Therefore, there is a critical need for raising awareness, education, dissemination, and the tools and technology with which to start implementing.

B. Connect Everything to Everything

One of the fundamental characteristics of innovations that have truly changed the world is that of connecting things, especially data and people. Trains, planes and automobiles; television, telecommunications, the Internet and the World Wide Web have each and all fundamentally altered our transaction space as well as the nature and diversity of our interactions. Learning objects have, an enormously high potential to take digital connectivity to a new level. On the data level, metadata (as previously discussed) will be the key to enabling the connectivity of learning objects by supplying the basis for making these connections between other learning objects and between people. On the technical and system architecture side, it will likely be new paradigms of the web and its related technologies that will make these connections possible.

While the rise and fall of the Napster web site for downloading music files (most of which are illegal copies) has attracted significant attention to the power of peer-to-peer file sharing, the real learning that is emerging is the power of such direct connections between people and content. New which is designed to allow people to distribute and retrieve information with complete anonymity, and to operate without any central control. This type of file sharing technology enables the connectivity of everyone and everything on the web. In the near future, we will

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see the emergence of more "blended" solutions, which combine the complimentary powers of both peer to peer and client/server models.

C. Everything Is "Just" a Node

Imagine what it means to have no concept of centralized servers or control. Where everything is "just" a node on the net. A world where every person and every file can be connected directly, one to one; indirectly through webs of such connections; and one to many. Think of the impact on learning, learners, and learning content. Think about every learning object connected to every other learning object, able to communicate, pass data, and manipulate the other. Think about a world where control of content is truly put into the hands of every individual or their designated assistants, where everyone in need of a given skill or knowledge can be connected directly with those who have it. What will it mean to have potentially billions of authors and publishers?

IX. Summary: Living in a World of Convergence

In a world of constant and increasing rates of change, one of the most prevailing trends and traits is that of convergence. Technologies converge to create new technologies and products; concepts converge to form completely new concepts; people converge into new local, global, and virtual communities; and professional skills converge to create new professions. However, these convergences pale in comparison to the implosion of learning, working, and capturing knowledge, and the management of their sum total. These previously disparate and relatively independent activities are converging to become one, producing unimaginable amounts of creativity, innovation, productivity, and performance. This fusion will create an infinite supply of the new energy source of the new knowledge economy. In this new knowledge-based economy the idea of "learning a living" will become our reality. So, welcome to the future. Welcome to the wonderful world of learning objects. Perhaps the greatest challenge of all is how can we as people also become more effective and efficient as "learning objects" ourselves.

Acknowledgments

Thanks to the many other pioneers, too numerous to mention individually, who have contributed over many years to the development and current realization of this vision for learning objects and the bright future of effective learning. Thanks to colleagues and supporters at Autodesk, Inc., including David Sanchez and Ernest Gmunder.

Special thanks to Ellen D. Wagner, Director of Learning Technologies with the Learnativity Alliance (<www.learnativity.com>) for assembling and editing this compilation of previous papers and new text with great skill and speed.

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Author's Biography

Mr. H. Wayne Hodgins is the Strategic Futurist and Director of Worldwide Learning Strategies at Autodesk Inc., the world's leading design and digital content creation resource. In this role he is the chief architect responsible for increasing human performance (employees, partners & customers) through what he refers to as Learnativity. Mr. Hodgins is also the President and co-founder of the Learnativity Alliance which works at the intersection of learning, productivity, creativity and activity and is the inflection point of the New Learning Economy.

Mr. Hodgins is regarded one of the most thought provoking visionaries and globally sought after keynote speaker on future directions in information and data models, metadata, standards, learning and human performance improvement. Known by many as "Mr. Metadata" and commonly referenced as the "father" of Learning Objects, having conceived the conceptual model and term over 10 years ago, Mr. Hodgins is a strategic advisor to industry, government and academic groups, commissions and associations worldwide. He is closely involved in the learning technology standards community including ISO, IEEE, IMS, W3C, ADL SCORM, ARIADNE and others.

Mr. Hodgins was heavily recruited from Vancouver, B.C. Canada, to join Autodesk in 1988 after almost 15 years in secondary, post secondary and industry education where he held positions of teacher, lecturer, department head, trainer counselor and principal in Canada and Europe. He is currently the elected Chair of the IEEE P1484 Standards Working Group for Learning Object Metadata, a key advisor and contributor to the Advanced Distributed Learning initiative and has been recognized as a world leading educator including the 1988 Marshall McLuhan Most Distinguished Teacher award, Top Ten CLO (2001), "New Breed of Visionary for 21st Century" and one "Six for the 21st Century Visionaries" (2000).

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