

CTL 1606 – Computers in the Curriculum

Object-based Education: the SMART Education Object (SMARTEO)

This paper details the research behind the SMART Education Object (SMARTEO). SMARTEO is my proposal for an “object-based” educational strategy for my employer, SMART Technologies Inc. During the two years I’ve been at SMART, we’ve been using a “granular” model for the design and development of training. To date this strategy has been implemented in an ad hoc manner. This paper presents the research behind what I hope will be a valuable learning tool for the customers and staff (SMARTians we like to call ourselves ; -) of SMART Technologies Inc.

I became interested in an object-based model for training following my introduction to the *Reusable Learning Object (RLO)*¹ in use at Cisco Systems, Inc. The RLO was developed by Dr. Ruth Clark² and is based on the *Component Display Theory (CDT)*³ work of Dr. M. David Merrill⁴. Since I first heard of object-based educational strategies in the spring of 2001, I’ve encountered a number of papers and articles related to objects and their use for learning and educational purposes. In fact, there are a number of different theories about what constitutes an object and how they are best used in education.⁵ I also found the work of a colleague of Merrill’s at Utah State University, Dr. David Wiley⁶, valuable in my understanding of objects and their educational use.

The RLO offers one model for development of a component-, or object-based educational strategy. There is a fair amount of research on the use of objects for educational purposes; however, there seems to be some discrepancy in the literature as to what exactly constitutes an “object” as it relates to learning or knowledge and how they should be used for learning or education. The University of Wisconsin offers a valuable overview of the topic.⁷

While my research began with a focus on objects themselves, it has become apparent to me that the social dynamic of (information and communication technology) ICT-based education plays a significant role in the evolution of object-based learning. For instance, I’ve seen first-hand how theory and practice have evolved in this area through my participation in the University of Toronto’s Knowledge Media Design Institute’s *Technology in Support of Learning and Teaching* Spring Lecture Series.⁸ Each week’s lecture provided new information on how technology is being used for educational purposes. In addition to the content of each lecture, I was most interested to see how the delivery medium (ePresence) evolved over the span of the series.⁹ Hats off to those at work getting the venue ready for “prime time” each week. I really enjoyed participating and interacting as an online “attendee” and I learned a lot about educational webcasting.

Lecture content pointed me to different areas for further study and research. Three lectures in particular were pertinent as I looked for an object-based educational model for SMART:¹⁰

Date	Lecture	Speaker(s)
February 6, 2002	MIT's OpenCourseWare Initiative: A Major Initiative in Global Information Sharing	Steven R. Lerman, MIT Class of '22 Professor, Director, Center for Educational Computing Initiatives, Chair of the MIT OpenCourseWare Interim Management Board; with President Robert Birgeneau, Dean Carl Amrhein, and Ron Baecker, University of Toronto
February 27, 2002	Educational Webcasting: Technology, Process, Uses, and Issues	Ron Baecker (UToronto), Dr. Bob Hsuing (Faculty of Medicine, University of Chicago), Dan Keating (OISE/UToronto)
March 27, 2002	Metadata, objects and repositories: Steps towards the Semantic web in Education	Terry Anderson, Professor and Research Chair in Distance Education, Athabasca University

Each of these lectures, and the rest of those in the series, may be accessed and viewed via the ePresence Series Archive.¹¹ Each lecture has been posted in three streaming (Windows Media, Apple QuickTime, and RealOne) video formats to ensure accessibility.

The OpenCourseware (OCW) Initiative¹² at the Massachusetts Institute of Technology (MIT) is a very exciting development for educators. Professor Lerman¹³ presented an overview of the initiative and how it is expected to benefit those in "bricks and mortar" classrooms at MIT. In essence, OCW will ultimately result in every course at MIT having its own web site. It is also expected that the "open" nature of the initiative will bring the same collaborative and knowledge building dynamic to OCW that has been experienced in "open source" software development initiatives (e.g., The Open Source Initiative¹⁴ and the World Wide Web¹⁵). MIT has another promising "open" initiative, as well. The Open Knowledge Initiative (OKI)¹⁶ is a very exciting initiative for the sharing of information between educational institutions. The OKI is "defining an open architectural specification to be used for the development of educational related software."¹⁷

Dr. Ron Baecker's¹⁸ lecture on the use of educational webcasting is also intriguing. Training for the products we produce at SMART Technologies Inc. pertains to both hardware devices and software applications. Because of the wide range of products and applications we produce, I feel it is important to offer training in a variety of media. Educational webcasting holds appeal for a number of reasons. Chief among these is the opportunity it presents to "show" learners what it is I'd like them to do. For instance, it may be easier to show someone, via video, how to connect and operate a SMART Board™ Interactive Whiteboard in projected mode, than it would be to "tell" how to make the connections through a series of procedural steps. Of course, both "showing" and "telling" might be used to ensure that the task (connecting a SMART Board Interactive Whiteboard in projected mode) is completed. Another aspect of educational webcasting that appeals is the ability to archive recorded classes, lectures, procedures, seminars, or sessions and post them as a resource for learners. I know from my use of the archives of the Spring Lecture Series that archives are a very useful resource for viewing or reviewing learning content.

I also found Dr. Terry Anderson's¹⁹ lecture on metatagging, objects, repositories and the Semantic Web²⁰ in education fascinating. Following this lecture I spent a lot of time researching the links he cited in his talk. During his lecture, Dr. Anderson provided some background on metatagging, and cited three examples (i.e., Dublin Core²¹, IMS²², and CanCore²³). Dr. Anderson indicated that CanCore represents a "happy medium" between the other two specifications. The Dublin Core identifies 15 metatag elements for each object, the IMS specification identifies 86 and CanCore lists 54 elements. Each specification has a "core" or minimum number of elements, and CanCore includes the "core" elements of the IMS specification.

Dr. Anderson added that CanCore is Sharable Content Object Reference Model (SCORM)²⁴ compliant. SCORM recognizes a CanCore object as a "raw media" object. He indicated that educational modeling language (EML)²⁵ holds promise and North American researchers have fallen behind their European counterparts in this area. I especially like what he has to say about the work being done by Tim Berners-Lee – "you remember him, don't you?" – and others, on the Semantic Web and the implications for education.

Dr. Anderson also talked about object repositories and provided links to the Broadband Enabled Lifelong Learning Environment (BELLE)²⁶ and Campus of Alberta Repository of Educational Objects (CAREO)²⁷ as examples of work being done in this area. My favorite is the "Experiential X-Ray Review for Cardiorespiratory Students"²⁸ BELLE object. This educational object includes an interface which allows students to practice reading x-rays. Students are asked to drag and drop labels onto the x-ray.

While looking around the Academic Technologies for Learning²⁹ lab at University of Alberta and the CanCore site, I happened across the work of Dr. Norm Friesen³⁰. I found Dr. Friesen's presentation, "Metadata and Educational Objects: The CanCore Solution"³¹ helpful as an example of how one might implement CanCore-based metatags. I also found "Cancore: Learning Object Metadata"³², a paper Friesen authored with Anthony Roberts and Sue Fisher, provides a valuable perspective on reusability, objects and metatagging.

During the Question Period following Dr. Anderson's lecture, I asked him for his thoughts on "granularity" and objects. "Just how big or small should they be?" Dr. Anderson responded that this is a "good question" without a ready answer. He stated that too small and objects are essentially entries in a database, too large and reusability is lost.³³

Here's what David Wiley and colleagues have to say about the "current views of granularity" as they relate to learning objects:

Inasmuch as granularity relates to scope, the study of instructional design theories that deal explicitly with scoping issues (e.g., Reigeluth's (1999) Elaboration Theory, van Marriënboer's (1999) Four Component ID Model, and Gibbons et al.'s (1981) Work Model Synthesis approach) can generally shed light on the issue of granularity. Reigeluth and Nelson (1997) suggested that when teachers first gain access to instructional materials they often break the materials down into their constituent parts, finally reassembling these parts in ways that support their individual instructional goals. This description captures one of the basic notions behind the learning objects idea: "pre-deconstruct" instructional media in order to increase the efficiency of instructional design (by eliminating the initial deconstruction step). However, because granularity and combination are so closely related when dealing with learning objects, a more robust view of granularity must be developed recognizing that future learning object combinatory possibilities will be a function of immediate granularity decisions. Two varieties of such a view have been put forward.

The first view of granularity is being championed by several specifications and standards organizations, namely the IMS Global Learning Consortium, the Advanced Distributed Learning Network, and the Learning Objects Metadata working group of the IEEE's Learning Technology Standards Committee. Each of these organizations describes an "aggregation level" in their respective learning object metadata element set (Anderson & Wason, 2000; Dodds, 2000; Hodgins, 2000). The aggregation level is defined as what one might consider the traditional course hierarchy, with a full course being the largest grain size and a single element of instructional media (e.g., an image) being the smallest grain size. Between these extremes two additional levels of aggregation are defined. When several of the smallest elements are combined (e.g., into a web page) they become a "Level 1 resource," and when several Level 1 resources are combined (e.g., into a web site) they become a "Level 2 resource." Thus these organizations view the level of granularity of a learning object as the degree to which small media elements have been combined to comprise the larger learning object. This is a media-centric definition of granularity.

The second view of granularity is more recent and less widely known. Wiley (2000b) defined granularity in terms of work model complexity, suggesting a semi-linear relationship between the relative size of a learning object and the relative complexity of the content whose learning the object is meant to support. Similarly, South and Monson (2000) defined granularity in terms of the domain content of a learning object, suggesting that objects "have the greatest potential for reuse when they center on a single, core concept" (p 5.). Both of these formulations view granularity as the degree to which elements of domain content are combined within a learning object. This is a content or message-centric definition of granularity.³⁴

Notwithstanding the *granularity* of objects, Wiley's recent research includes consideration of the social aspect of online learning. His paper, authored with Erin K. Edwards, *Online self-organizing social systems: The decentralized future of online learning*³⁵ presents the authors' thoughts on the "social" aspect of online learning and how knowledge building efforts are expected to evolve online.

But not all advances in instructional technology come about through the development of new hardware or software – some emerge from the creative applications of existing technology. In this article we discuss such an innovation, the online self-organizing social system (OSOSS). Briefly described, the OSOSS structure allows large numbers of individuals to self-organize in a highly decentralized manner in order to solve problems and accomplish other goals. The OSOSS structure is neither an instructional design theory (such as those described by Reigeluth, 1999) nor an application or Internet protocol (such as Netscape or HTTP). However, due to its distributed and highly decentralized nature, the authors feel that the OSOSS structure could prove as disruptive to traditional notions of online learning as Napster proved to traditional conceptions of the Internet.³⁶

By virtue of the dynamic of OSOSS and presence of "meta-moderation" (i.e., moderation of the moderators) participants are able to interact and build knowledge in ways that the instructional designer hadn't considered. The infrastructure is put in place and participants are "left to their own devices." The authors cite Slashdot.org as an example of what they describe as "real-time peer review."

The combination of Slashdot's moderation system with its meta-moderation system creates a powerful infrastructure for real-time peer review. This infrastructure supports the community's efforts to bring the best information, questions, and answers to the attention of the community, while making it difficult for misinformation and half-baked ideas to propagate across the network. In short, it functions much like the peer review process that provides the gateway to academic journals. It impressively fills this role a) in real-time, b) with input from a larger proportion of the community, and c) with meta-moderation

checks in place to prevent abuse .³⁷

To me, the greatest strength of the OSOSS model is its reliance on participants to drive the process. Participants are expected to “locate, assemble and contextualize the resources.” Such a system will ultimately meet the “needs” of a particular population of learners, because of the “self-determined” nature of such a system. Furthermore, the distributed nature of OSOSS works to ensure that no one individual is “unduly burdened.”

The most significant departure of the OSOSS from conventional learning objects approaches is that it relies on human beings to locate, assemble, and contextualize the resources. Although the tragedy of the commons (Hardin, 1968) would suggest that such voluntary collaborations are not sustainable over time, the emergence of the Internet, and specifically the Free/Open Source Software movements, have shown peer-to-peer communications technology’s ability to put people in symbiotic, “you answer my question, I’ll answer yours” relationships. The gift culture described by ethnographers of the Free/Open Source movements such as Raymond (1999) and Himanen (2001) is one explanation of this phenomenon. Another explanation is that a distributed expertise model obtains in sufficiently large distributed learning communities, meaning that because expertise exists across the community no individual community member is overly burdened with the primary responsibility for answering questions and providing feedback. As problems arise related to the expertise of an individual, that individual may or may not choose to provide help. If the community is of sufficient size, the distribution of expertise and effort provides timely problem solving support without unduly burdening any individual .³⁸

Wiley and Edwards recognize that there are some issues inherent in the implementation of any instructional strategy, and identify two “prime areas for further research”

We see the prime areas for future research in OSOSS as twofold: more thorough ethnographic and discourse studies of existing OSOSS, including grounded theory studies that could guide the creation of software infrastructures to facilitate the development of these communities, and studies of ways around the weaknesses in OSOSS. The main obstacle to this research will be the large numbers of participants necessary for self-organization to occur, but the promise of the OSOSS approach merits the effort on the part of researchers .³⁹

At SMART Technologies Inc. we’ve recently begun to offer a series of half-day F2F training sessions. This training program is called the SMART Master’s Program. Offerings include On-Site⁴⁰ and Train-the-Trainer⁴¹ Sessions, and Events⁴². On-Site and Train-the-Trainer sessions are typically conducted at customer sites, while “Events” are hosted by SMART Technologies Inc. and are conducted in locations across North America. Upon program completion learners are invited to participate in an asynchronous, text-based online discussion group.

I’m hopeful that, in time, the number of “alumni” participating online will constitute a “critical mass” and provide the “large numbers of participants necessary for self-organization to occur.” Ideally, those who’ve completed the Master’s Program will use the discussion group to form an “online self-organizing social system (OSOSS).” Of course, “meta-moderation” will include leading by example and modeling of the behavior expected and accepted in the forum. Posting of “ground rules” or a “code of conduct” will set out “best practices” and let learners know what is expected. Ultimately, it will fall to the group itself “self-moderate,” with meta-moderation continuing as a “check” or “balance.”

Because of the “user-defined” nature of OSOSS, I’m hesitant to be too prescriptive in my definition of the SMART Education Object (SMARTEO). There are a number of metatagging specifications that

are currently in use and any one of these could be adopted and used as the basis for the SMARTEO. I've decided, at this point in the process, to avoid adoption of one metatagging specification over another. I've made this decision because I'm not sure of the level of specification we need for SMARTEO (I need to see objects "in action" to determine what level(s) of granularity are needed). I'm also hesitant to constrain learners as they "self-organize" their object-based educational experiences.

I've arrived at the following model for the SMART Education Object (**SMARTEO**). I believe it provides enough structure to get started, while not being restrictive. I hope to use this model as for both online and F2F educational activities. I expect the model to evolve as we move forward with object-based educational strategies at SMART Technologies Inc.

Subject – subject matter, title, or task to be completed. The learning objective of the object, "upon completion of this object, you'll be able to..."

Media – method of delivery. PDF-based page-turners, face-to-face (F2F) or online classes or seminars, computer-based (i.e., CD/DVD) or streaming videos, or asynchronous or synchronous chats.

Assessment/Application – assessment of needs. Is training needed? What are the learning needs of the population? What is it that learners need to know? What do they know now? Assessments may be developed in a variety of media. Page-turners⁴³ and online assessments⁴⁴ will help to determine the actual "needs" of learner population and direct learners to appropriate content. Activities and exercises will allow learners to synthesize and apply the content presented via **media**.

Review – review of learning content. Results will determine areas requiring more work. Reviews may be paper-based, F2F, CGI-scripted, or web- or game-based feedback forms. Online forms should provide remedial suggestions to learners "on the fly."

Test – test of acquired knowledge. Did you get it? May also be used as a "challenge exam" for learners that would like to skip "prerequisites" where they exist.

Evaluation – the evaluation stage allows learner assess the educational effectiveness of a given object? Did I learn what I needed to learn? Does the object need to be changed? Which objects can/should be grouped together?

Outcome – overall, or "meta" assessment of the object. Should we keep this object? Are supplements needed? An OSOSS-based vetting of objects would ensure relevance to learners and assure the educational value of a given object.

I'm hoping this taxonomy will help to define the notion of objects for stakeholders and encourages them to make SMARTEO of their own. The Quick References, Hands-on Practices and 10-Minute Tools available at the SMART Training Center⁴⁵ provide examples of text- and video-based "educational objects." I hope learners will build on these examples with some of their own. For instance, SMART Recorder, allows anyone with a SMART Board Interactive Whiteboard™ to make an AVI format file of actions at the board. This allows the creation of an object related to some

operation of software. If the attached computer has a sound card and microphone, a voice recording can be added. I'm interested to see what learners come up with in the way of SMART Recorder file-objects.

In addition to what's developed in AVI format, I'm especially interested in seeing how OSOSS relates to video-based ICT educational activities. I'd like to experiment with Internet Protocol (IP) and Integrated Services Digital Network (ISDN) videoconferencing. Much like the discussion group, I envision a day when customers and meet via video – maybe on a periodic basis – to discuss and implement “the creative applications of existing technology.” How best to use objects across levels of granularity and types of media will probably be the biggest obstacle to a comprehensive strategy based on this model; however, leveraging existing training materials, and providing learners with the ability to assess and address learning needs will lead to the ultimate definition of SMARTEO.

There is a lot of exciting work being done in ICT and we at SMART are very fortunate to have strong relationships with researchers in a number of “channels” (business, education, government, military) the world over. I'm hopeful this paper will provide a “jumping off” point for discussions related to objects, metatags and repositories and how each can be used to better meet the educational and training needs of the customers and staff of SMART Technologies Inc.

References and Notes

- ¹ Maddocks, Peg. "Case Study: Cisco Systems Ventures into the Land of Reusability" *Learning Circuits*, March 2002. <http://www.learningcircuits.org/2002/mar2002/maddocks.html> (01 May. 2002).
- ² Clark, Dr. Ruth Colvin. "CLARK Training & Consulting: Professional Staff" <http://www.clarktraining.com/staff.html> (04 Jan 02).
- ³ Kearsley, Greg. "Component Display Theory (M.D. Merrill)" <http://tip.psychology.org/merrill.html> (05 May 02).
- ⁴ Merrill, M. David. "M. David Merrill" <http://www.id2.usu.edu/MDavidMerrill/> (04 Jan 02).
- ⁵ Mortimer, Lori. "(Learning) Objects of Desire: Promise and Practicality" *Learning Circuits*, April 2002 <http://www.learningcircuits.org/2002/apr2002/mortimer.html> (22 Apr 02).
- ⁶ Wiley, Dr. David. "david wiley" <http://wiley.ed.usu.edu/> (02 Feb 02).
- ⁷ Academic ADL Co-Lab (AADL), the University of Wisconsin System (UWS), and Wisconsin Technical College System (WTCS). <http://adlcolab.uwsa.edu/lo/what.htm> (24 Feb 02).
- ⁸ The Spring Lecture Series at the University of Toronto's Knowledge Media Design Institute "ePresence Archived Events" <http://epresence.kmdi.toronto.edu/archived.asp> (04 May 02).
- ⁹ Symington, Doug. "KMDI Journal" <http://home.oise.utoronto.ca/~dsymington/KMDI/KMDIjournal.html> (05 May 02).
- ¹⁰ The Knowledge Media Design Institute at University of Toronto's "Technology in Support of Learning and Teaching Spring 2002 Lecture Series" <http://www.kmdi.org/schedule.html> (05 May 02).
- ¹¹ Knowledge Media Design Institute. "ePresence: Archived Events" <http://epresence.kmdi.toronto.edu/archived.asp> (05 May 02).
- ¹² Massachusetts Institute of Technology. "Open Course Initiative (OCW)" <http://web.mit.edu/ocw/> (05 May 02).
- ¹³ Lerman, Dr. Steven. "Prof. Steven R. Lerman" <http://caes.mit.edu/people/lerman.html> (05 May 02).
- ¹⁴ The Open Source Initiative. "Home Page" <http://www.opensource.org/> (05 May 02).
- ¹⁵ World Wide Web Consortium <http://www.w3.org/> (05 may 02).
- ¹⁶ Massachusetts Institute of Technology. "Open Knowledge Initiative (OKI)" <http://web.mit.edu/oki/map.html> (05 May 02).
- ¹⁷ Massachusetts Institute of Technology. "Open Knowledge Initiative (OKI)" <http://web.mit.edu/oki/ovrvw/index.html> (05 May 02).
- ¹⁸ Baecker, Dr. Ron. "Dr Ronald M. Baecker's Home Page" <http://www.dgp.toronto.edu/people/RMB/> (05 May 02).
- ¹⁹ Anderson, Dr. Terry. "Terry Anderson" <http://www.athabascau.ca/html/staff/academic/terrya.html> (06 Apr 02).
- ²⁰ W3C Semantic Web. "W3C Semantic Web" <http://www.adlnet.org/index.cfm?fuseaction=scormabt> (05 May 02).
- ²¹ Dublin Core Metadata Initiative (DCMI) "Dublin Core Metadata Initiative (DCMI)" <http://dublincore.org/> (05 May 02).
- ²² IMS Global Learning Consortium, Inc. "Welcome to IMS Global Learning Consortium, Inc." <http://www.imsproject.org/> (05 May 02).
- ²³ Cancore. "Cancore: Home" <http://caes.mit.edu/people/lerman.html> (05 May 02).
- ²⁴ Advanced Distributed Learning Network (ADLNet). "SCORM Overview" <http://www.adlnet.org/index.cfm?fuseaction=scormabt> (05 May 02).
- ²⁵ OpenUniversiteitNederland. "Educational Modelling Language" <http://eml.ou.nl/> (05 May 02).

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- ²⁶ BELLE: Broadband Enabled Lifelong Learning Environment. "The BELLE Project led by Netera Alliance" <http://belle.netera.ca/> (05 May 02).
- ²⁷ CAREO: Campus of Alberta Repository of Educational Objects "CAREO: Campus of Alberta Repository of Educational Objects" <http://www.careo.org/> (05 May 02).
- ²⁸ Academic Technologies for Learning, Faculty of Extension, University of Alberta. "Projects - Experiential X-Ray Review for Cardiorespiratory Students." <http://www.atl.ualberta.ca/project/detail.cfm?id=62> (05 May 02).
- ²⁹ Academic Technologies for Learning, Faculty of Extension, University of Alberta. <http://www.atl.ualberta.ca/> (05 May 02).
- ³⁰ Friesen, Dr. Norm <http://www.atl.ualberta.ca/whatisatl/staff/Norm/> (05 May 02).
- ³¹ Friesen, Dr. Norm. "Metadata and Educational Objects: The CanCore Solution" http://www.cancore.org/MetadataandEducationalObjects_files/frame.htm (05 May 02).
- ³² Cancore. "Cancore: Learning Object Metadata" <http://www.cancore.ca/cancorepaper.doc> (05 May 02).
- ³³ Knowledge Media Design Institute. "ePresence: Archived Events" <http://epresence.kmdi.toronto.edu/archived.asp> (05 May 02).
- ³⁴ Wiley, David A., Gibbons, Recker. "A reformulation of the issue of learning object granularity and its implications for the design of learning objects." <http://wiley.ed.usu.edu/docs/granularity.pdf> (25 Apr 02).
- ³⁵ Wiley, David A. and Erin K. Edwards "Online self-organizing social systems: The decentralized future of online learning" <http://wiley.ed.usu.edu/docs/ososs.pdf> (25 Apr 02).
- ³⁶ Ibid.
- ³⁷ Ibid p 6.
- ³⁸ Ibid p 11.
- ³⁹ Ibid p 14.
- ⁴⁰ SMART Technologies Inc. "SMART Master's Program – On-Site Sessions" <http://www.smarttech.com/trainingcenter/masters/onsitesession.asp> (05 May 02).
- ⁴¹ SMART Technologies Inc. "SMART Master's Programs – Train the Trainer Sessions" <http://www.smarttech.com/trainingcenter/masters/trainthetrainer.asp> (05 May 02).
- ⁴² SMART Technologies Inc. "SMART Master's Program – Events" <http://www.smarttech.com/trainingcenter/masters/events.asp> (05 May 02).
- ⁴³ "Page-turner" assessments like those produced by the Education Commons at the Ontario Institute for Studies in Education (OISE) could be used to allow potential students to self-assess their learning needs. <http://www.oise.utoronto.ca/ec/ecer/testyourself.html> (04 May 02).
- ⁴⁴ Online assessments like those available, for instance, through the Free Assessment Summary Tool at Mount Royal College (www.getfast.ca) or Hot Potatoes at the University of Victoria (<http://web.uvic.ca/hrd/halfbaked/>). (04 May 02).
- ⁴⁵ SMART Technologies, Inc. "SMART Training Center" <http://www.smarttech.com/trainingcenter/index.asp> (07 May 02).