# A WebCT-based Distance Learning Course to Teach Water and Nutrient Management Planners for the Nursery and Greenhouse Industries

John D. Lea-Cox
Dept. of Natural Resource Sciences
and Landscape Architecture
University of Maryland
College Park, MD 20742
USA

David S. Ross
Dept. of Biological Resources Engineering
University of Maryland
College Park, MD 20742
USA

Ellen N. Varley
Distance Learning Unit, Communications
and Information Technology Office
University of Maryland
College Park, MD 20742
USA

K. Marc Teffeau
Wye Research and Education Center
University of Maryland
College Park, MD 20742
USA

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**Abstract**

**In response to a legislative and environmental mandate, an interdisciplinary faculty team at the University of Maryland developed an interactive, WebCT-based course entitled "Water and Nutrient Management Planning for the Nursery and Greenhouse Industry". This course utilizes the rich educational potential of the web to provide a learning experience for resident students, together with widely dispersed nursery and greenhouse professionals. This course was designed for online delivery with little or no face-to-face interaction, for credit and non-credit (certification) purposes. By using a problem-based learning approach and with guidance from the faculty, learners analyze, synthesize and evaluate information to enable them to create and implement site-specific water and nutrient management plans for individual nursery and greenhouse operations. During the four semesters this course has been offered, teams of students, growers, and consultants have written 31 plans as case-studies, with 85 students in five states and Ontario successfully completing the course. The role of the faculty was to facilitate independent learning and collaborative inquiry. The faculty team made key design decisions, using a range of collaborative tools and pedagogical methods to develop and deliver this award-winning course, to enable the learning process and make the technology transparent to the learner.**

## INTRODUCTION

### The Maryland Regulations

In 1998, the state of Maryland passed the toughest nutrient management law in the nation, requiring virtually all agricultural operations to write and implement nitrogen (N) and phosphorus (P)-based management plans by December 2002. This was in reaction to an outbreak of the organism *Pfeistieria* in tributaries of the Chesapeake Bay that induced fish kills and had negative health effects on some local fisherman. The law requires a nutrient management plan from all producers to ensure that anyone applying nutrients from either inorganic (chemical) or organic (manure) sources can account for the nutrients that are applied, and to make sure that nutrients are not applied in excess of crop requirements. The regulations require that all agricultural operations over 10 acres in extent or that have a gross annual income of more than US$2500 write a nutrient management plan. In effect, the last clause in the law included many smaller growers with far less acreage under production.

The legislation also mandates the education and training of professionals who will

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write nutrient management plans, and growers who will implement them. Maryland Cooperative Extension faculty have been charged with developing effective educational programs that will enable nursery and greenhouse industry professionals to achieve these goals and ensure industry compliance with this legislation. Further details on the Law and the nutrient management regulations can be found at the Maryland Department of Agriculture – Office of Resource Conservation website at http://www.mda.state.md.us.

**The Federal Regulations**

Newly enforced provisions of the Federal Clean Water Act of 1972 (Environmental Protection Agency, 2000) are ensuring that state governments develop a watershed approach to documenting and determining the origin of non-point sources of pollution to streams, rivers, lakes and estuaries. The new EPA proposal differs from current water regulations by broadening the focus of the law from monitoring specific discharges of pollutants from individual point sources, to instead focus attention on the overall quality of a body of water. This takes into account the ability of the body of water to handle contaminants from all of the (point and non-point) sources of pollution that enter it. The focus on overall water quality requires each state to set a limit, known technically as a "total maximum daily load", for each body of water. So, for the first time, states would be forced to reduce "non-source" pollution from more diffuse sources, including agricultural and urban runoff.

**THE NUTRIENT MANAGEMENT PLANNING PROCESS**

The Maryland nutrient management legislation poses unique challenges for the nursery and greenhouse industry because a wide range of production scenarios are used to produce a large number of different species and types of ornamental plants, usually on small acreages. The first challenge in developing a course to train nutrient management planners was to develop a water and nutrient management process that integrated various cultural factors, i.e., substrate physical and chemical properties, fertilizer application methods and rates, and irrigation water application methods and duration (Lea-Cox et al., 2001). In considering these factors, a systematic water and nutrient management process was developed which utilizes a risk assessment approach (Lea-Cox, 2000; Lea-Cox et al., 2001; Ross et al., 2001). This approach provides a strategy that enables growers to capture site-specific information and write a nutrient management plan that will accurately assess the efficiency of these cultural practices. It was also important to develop a process that incorporates a relatively simple set of metrics that gives similar reporting data for very different growing operations so that plans can be objectively evaluated by the Maryland Department of Agriculture, as the regulatory agency.

The process that resulted not only evaluates at nutrient movement from a physical point of view, but also captures management data (e.g. irrigation duration) that influence nutrient leaching and runoff from nursery or greenhouse production sites (Lea-Cox and Yeh, 2001). In consultation with the grower, the planner develops a set of "management units" that group plant production into the least possible number of units. Favored management units are "container size" categories since container size is a variable that most operations use to group plants and track sales. Crops in similar size containers receive similar amounts of water and nutrients, a key consideration for grouping them in this planning process. A relatively simple risk assessment is then conducted for each management unit, which translates information about water and nutrient management practices into quantitative data. This process essentially quantifies the risk of N and P moving from the nursery and identifies high-risk factors to the planner/grower. The final part of the planning process defined risk management options, best management practices, and monitoring procedures that will ensure the effective implementation of the plan (Lea-Cox et al., 2001).

## TRAINING NUTRIENT MANAGEMENT PLANNERS

No state had required mandatory nutrient management plans for nursery or greenhouse operations until now, so few people have had the incentive to formulate approaches to deal with this kind of environmental regulation. Our first challenge was to develop the planning process, and assemble the knowledge base that was required to support this effort. This dictated a team approach for content development, as the preparation of these types of nutrient management plans requires the synthesis of knowledge and skills from a number of different subject areas, including soils and soilless substrates, plant nutrition, irrigation, and surface water management. Since the environmental risk assessment/risk management concept is relatively new in agriculture, a case-study approach is an effective learning environment in which to learn these principles.

The second challenge was to develop a course that could be accessed by both resident university students and professionals within these industries. After the industry was surveyed (Teffeau et al., 1999), a web-based format was chosen to deliver the course, since nursery and greenhouse professionals are widely dispersed throughout the state, but most have access to the internet. WebCT courseware (WebCT, Inc., Lynnfield, MA; http://www.webct.com) provides the online learning environment for the course (Lea-Cox et al., 1999). The WebCT courseware is password-protected and housed on a secure server. Registered students can access the course any time and any place convenient to them by logging on to the course through the internet and by using any type of web browser (Fig. 1).

The course consists of six content modules covering the science or subject matter necessary to understand the water and nutrient management planning process (Fig. 2). These six modules are supported and enhanced by text resources, hypertext links to external websites and resources, photographs, graphic illustrations, powerpoint presentations, and video clips (Fig. 3). An unusual feature of the course was that growers, consultants, extension professionals and university students are partnered into teams. Each team writes a nutrient management plan for a real nursery or greenhouse (usually the operation of the grower on the team), during the course. By interacting as teams, students not only apply theoretical knowledge from the course, but also capture the experiential knowledge of the various professionals on the team, in situations where they are faced with solving real-life challenges (Kristof and Satran, 1995).

The course is delivered over a 12- to 16-week period, as the content requires time to assimilate and plan development is often detailed. Based on a beta-test of the course in 1999, we added five half-day “face-to-face” meetings at various nursery and greenhouse locations during the course delivered in Fall 2000 and the spring and fall of 2001. These on-site meetings allow the teams not only to see the physical layout of each operation, but also give them time to exchange ideas and ask direct questions. We have found that this motivates individual team members with individual and team assignments and affords us, the instructors, an opportunity to pace the course more effectively. Given the diverse geographical locations and backgrounds of the students enrolled in the course, the use of WebCT allows the students to access the course at any time or at any location convenient to them. This is especially important to industry professionals, as they are not required to come to campus at set class times to receive instructional materials.

This web-based course differs from traditional courses in several ways (Lea-Cox et al., 1999). It not only relies on traditional teaching techniques using text and illustrations and outside web resources within each module, but also provides an enhanced, interactive learning experience through use of assignments posted to discussion forums, which are linked to a variety of group and individual plan assignments in the course (Angelo and Cross, 1993). In the instructional design and implementation of this course, constructivist pedagogy is used within a case study environment. Utilizing the subject matter material placed within the WebCT courseware, hyperlinks, and external assignments found within the content modules, the students build a knowledge base of facts and information to integrate into a conceptual framework. By using the problem-based learning approach found in the case study, students use analysis, synthesis and

evaluation to create site-specific solutions to the specific production scenarios for each operation. The various assignments within each module are integral components of a risk assessment process. Risk assessment, however, is an inherently subjective process. The assignments allow the student to gain insight into how the objective, empirical measurements they make fit into the risk assessment matrix, which is later used to formulate risk-reduction management strategies. Other than general regulatory guidelines required by the Maryland Department of Agriculture, there is no "right" way to determine the most effective ways to reduce water and nutrient runoff. The students determine the correct course of action for each specific greenhouse or nursery and integrate those strategies into their nutrient management plan.

Individual and team assignments for each module are well documented within each content module and on the course calendar, together with the due date. Asynchronous discussion forums were used as the main method of exchanging information between students and faculty (Fig. 4). These fora not only thread the discussion postings, but various files and documents can be attached to individual messages and shared between course members. Each course has, on average about 40 individual and team discussion forums. Each student has a closed access forum in which to interact privately with faculty and to post their individual assignments. Team discussion areas are open to all course members. Team members are required to collaborate to complete the nursery evaluation (on-site assignments) and post the results of these assignments to the team forum. Assembling the various team assignments develops the final nutrient management plan. By sharing in the development process for different operational plans through postings to each team forum, each course participant has the opportunity to critically assess and learn from the approach taken by other teams (Pallof and Pratt, 1999). The instructors review each individual and team's posting giving feedback and guidance to the students. Each course has averaged over 1000 messages over 16 weeks. Students have assessed the content of the course as being intensive and complex, but they also feel the online environment requires much more time and is much more intense and demanding than a traditional face-to-face course.

The actual nursery or greenhouse site used in the case study is a unique resource that is integral to the course. Students are not given a theoretical, paper-based case to work on, but a real, operating nursery or greenhouse site from which to collect data and prepare a nutrient management plan. Assignments are reality-based. The team members conduct on-site evaluations of the physical layout and operational management of the nursery or greenhouse. They are required, as a team, to perform a series of specific tasks, including measuring and mapping growing areas, developing management units, assessing leaching fraction and irrigation interception efficiencies, together with documenting nutrient application rates. These data are then incorporated into the risk assessment matrix and final nutrient management plan. The final risk assessment is then translated into a series of best management recommendations to lower the risk of water and nutrients runoff. The course not only provides learners with the theoretical knowledge to write nutrient management plans, but it requires learners to translate that factual information into an actual plan, using critical thinking skills. Working with a real situation, and faced with the need to resolve unforeseen circumstances requires adaptive thinking since there are often no "right" or "wrong" answers to these complex problems.

As an added benefit, this process not only gives the grower an assessment of the nutrient runoff potential from the nursery or greenhouse operation, but also gives real insight into the cost-effectiveness of major cultural inputs and decisions in the business. The process can also provide the grower with data on the efficiency of the business and a range of alternatives to improve production and perhaps increase profitability.

Student progress is evaluated by a number of means including quizzes, the quality of participation in discussion forums, individual and team assignments posted by the students, and ultimately the quality of the team project, the water and nutrient plan. There is no "final exam" in this course. The nutrient management plan is the main assessment tool that is used to ascertain whether a student is competent. Final plans are signed by

certified nutrient management planners and are submitted for final review by officials of the Maryland Department of Agriculture, as the regulatory authority in Maryland.

## CONCLUSION

In conclusion, the course emphasis was to teach critical thinking skills which are prerequisite to being able to develop site-specific nutrient management plans for the nursery and greenhouse industries. The faculty role was to facilitate independent learning and collaborative inquiry. The primary intent of the course design process was to target various learning styles as well as the cognitive maturity of each learner. By using a problem-based learning approach, and with guidance from the faculty, learners analyzed, synthesized and evaluated information to enable them to create and implement realistic solutions to each case-study. Involving the industry professionals also allows the instructors to capture practical methods to achieve these goals and refine the planning process through critical feedback.

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## Figures

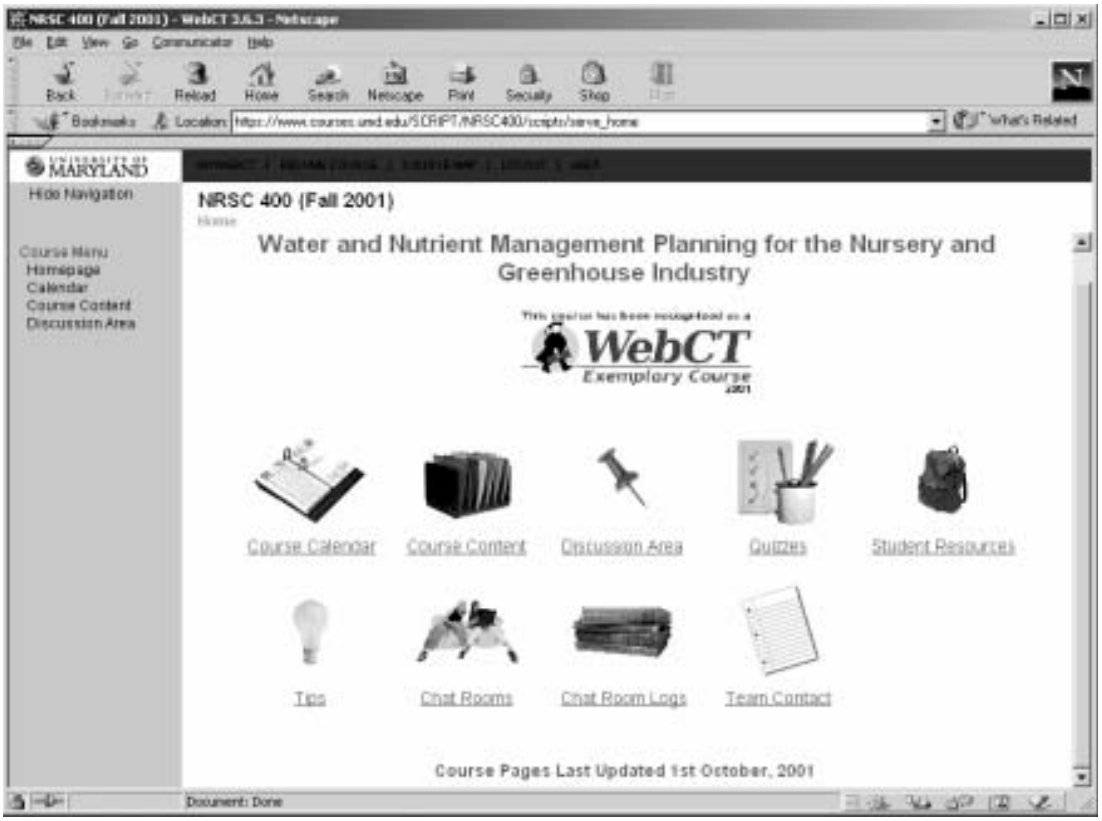


Fig. 1. Water and nutrient management planning for the nursery and greenhouse industry course homepage accessed over the internet with Netscape Navigator v 4.75 (Netscape, Inc., Mountain View, CA).

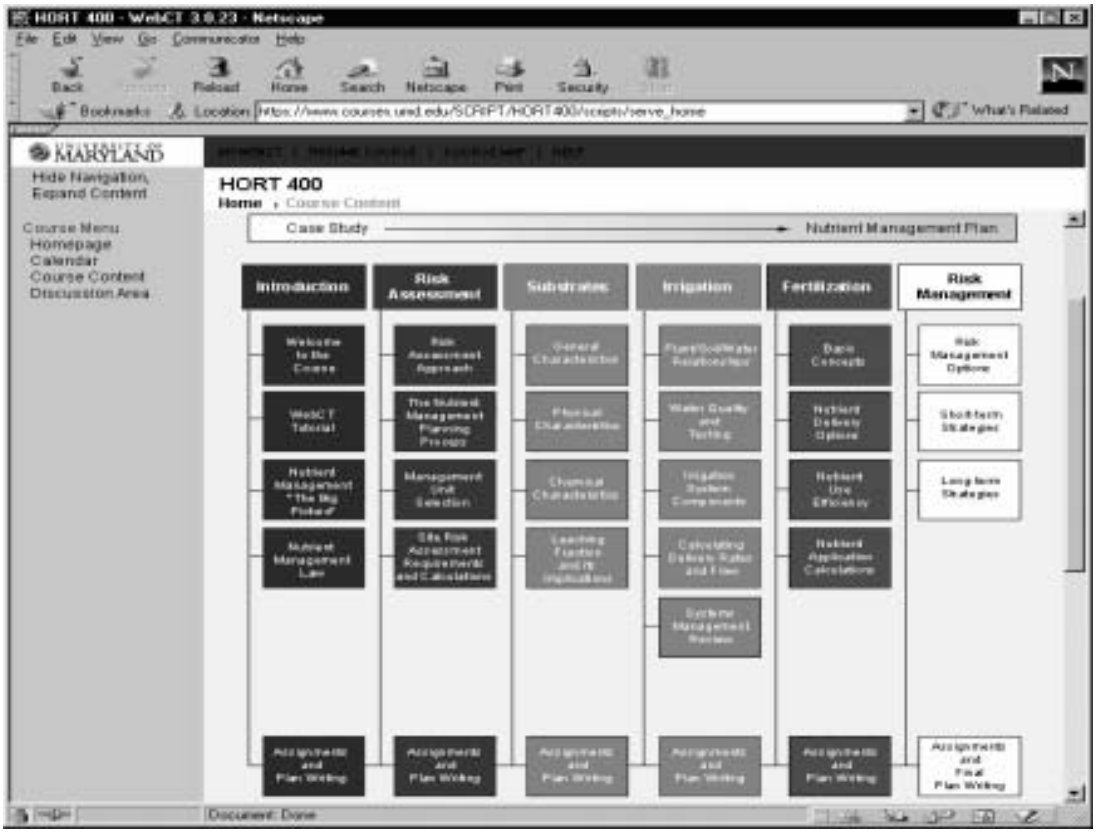


Fig. 2. Color-coded course content navigation map showing the individual course modules and sections. The top bar indicates the progression of the case-study and assignments over the period of the course.

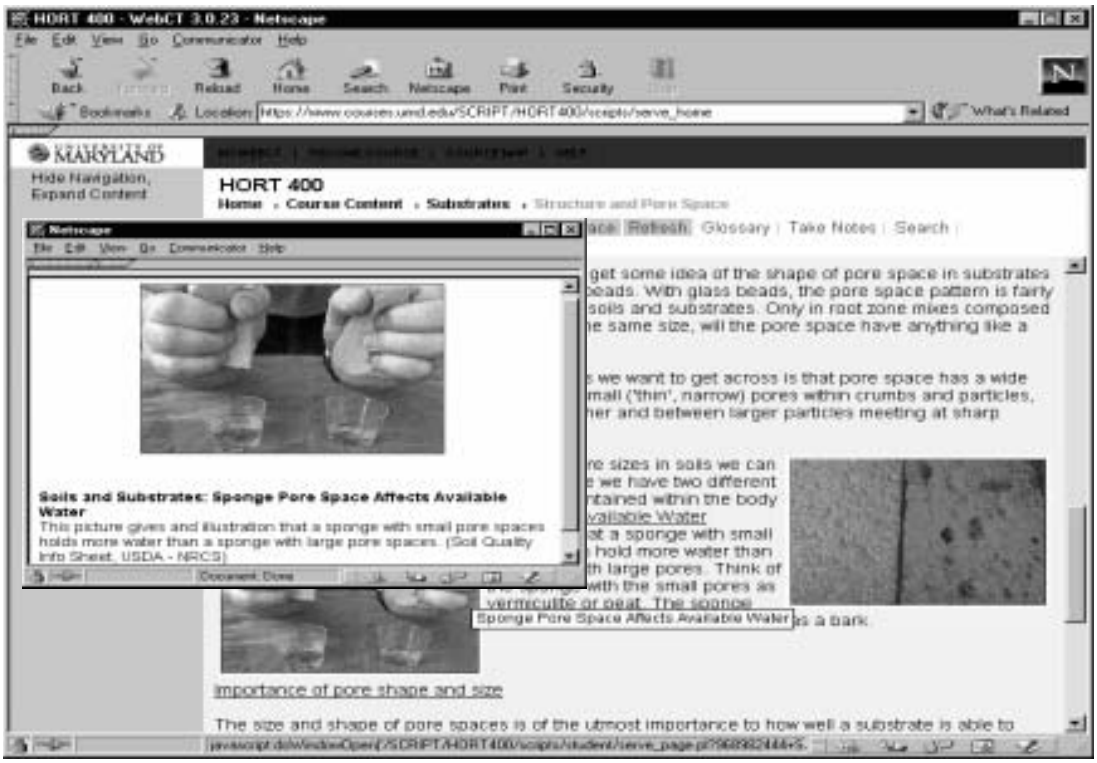


Fig. 3. An example of a course content page with text, visuals and hyperlinks to short video-clips on the course.

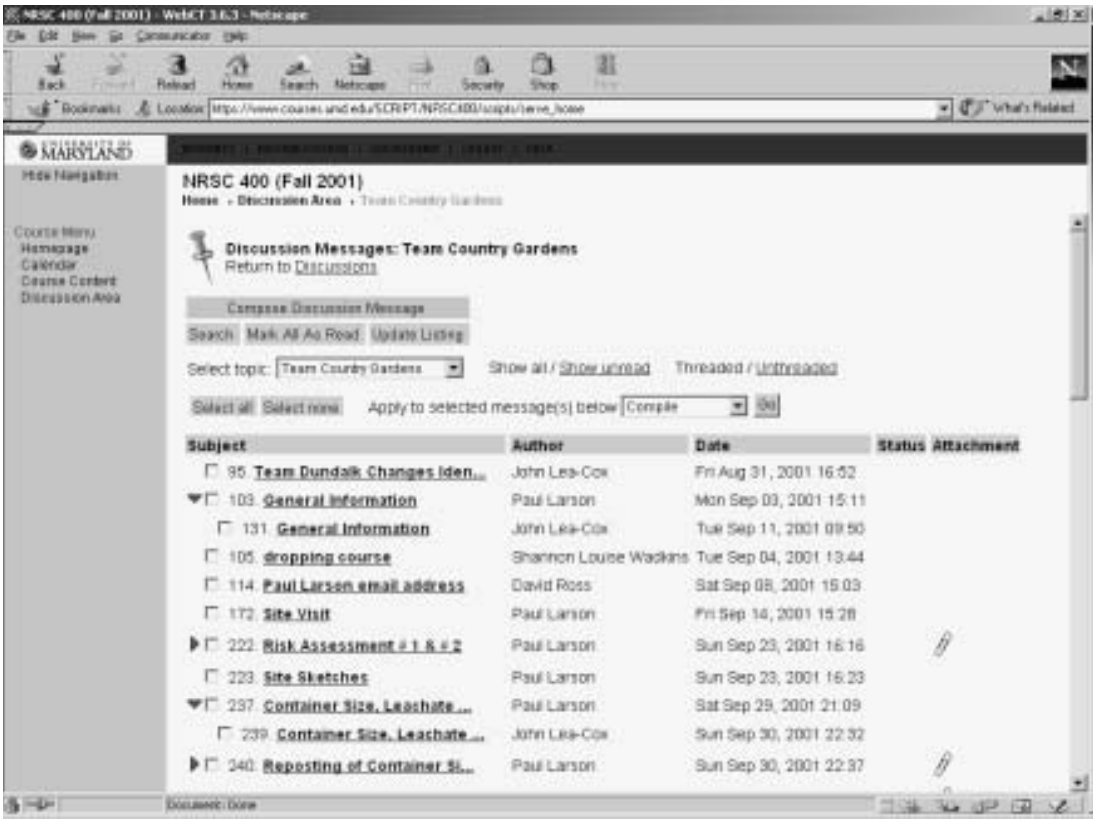


Fig. 4. A threaded asynchronous team discussion area where class participants share files and information for each operation, post assignments and receive constructive feedback from course instructors.