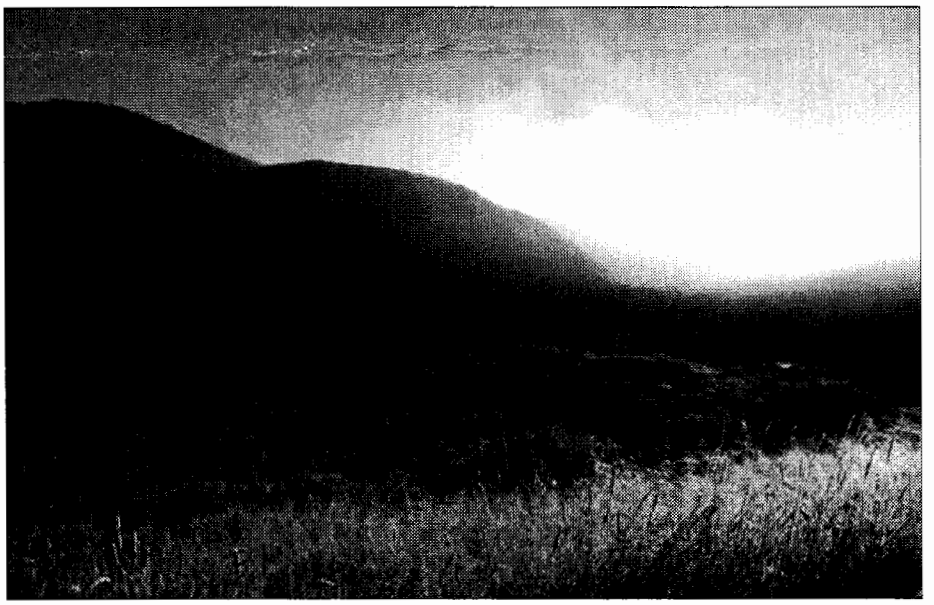
Winter 1997

C_3 News

Newsletter of College Chemistry Canada / La Chemie Collégiale au Canada



In this issue: Teaching Environmental Chemistry

Left: The Cardinal Divide Wilderness near Jasper National Park; site of the proposed Cheviot coal mine. Photo by Les Cheshire

Environmental Chemistry - a status report

Colin Baird, University of Western Ontario

I first heard the term Environmental Chemistry in the mid-1970s. At that time the initial wave of environmental concern was sweeping across North America, and as well we had an energy crisis on our hands. At Western we responded to the growing interest in the environment by initiating an energy-related course in about 1976, and then a full-fledged Environmental Chemistry course for our undergraduates in 1979 - the latter drew 35 students that first year, and steadily grew to about ten times that size. The subject content for this course was defined initially by the Environmental Chemistry textbooks then available - that by Moore & Moore, and the first edition of the ever-expanding tome by Manahan. Comparable courses were developed at other Canadian universities and colleges; indeed the authors of two of the four or five main textbooks now used around the world for such courses are Canadians.

The subject matter of Environmental Chemistry at the undergraduate level has undergone some evolution in the past twenty years. Although tropospheric air pollution has been in the curriculum from the start, the Ozone Hole crisis of the mid-1980s resulted in the incorporation of significant amounts of stratospheric chemistry. Similarly, the enhancement of the Greenhouse Effect by carbon dioxide and other gases now receives prominence. Water pollution and its remediation, and the low-level contamination of the earth

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In this issue

C_3 News

Volume 22, No. 4 Winter 1997

Published quarterly by College Chemistry Inc.

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Articles of any length will be gladly accepted. Please send typewritten copy to the Editor at the above address or send by fax. Copy can also be sent on a 3.5" disk, Mac or IBM format using Microsoft Word 6.0, or IBM format using WordPerfect 6.0 or lower, or any word processor producing ASCII output.

1997 College Chemistry Canada Inc. ISSN 0843-4956

Designed by R. Franchuk

Printed by Athabasca University

President's message

With the current labour unrest within Canada Post, I have no idea when you may actually be reading this. With luck our mail is flowing again quickly and you are reading this before Christmas. It is time once again to think about the C3 Award. I was very pleased to have presented the award to Bob Perkins in 1997, and I hope that I will have the honour of awarding it to someone in 1998 as well. The deadline for nominations is coming up, so please, if you know a C3 member who deserves this award, send their nomination in soon (the deadline has been moved to March 1). For the nomination procedure and selection criteria check out our web page.

Also, I am pleased to present the guidelines for a new student scholarship. Each year C3 awards a scholarship to a student at the hosting college. This year we will also be offering a general scholarship. The guidelines are presented below.

C3 Student Scholarship

Objective

To help a student pursue studies at a Canadian College (or other post-secondary educational institution) in science, and to raise the profile of College Chemistry Canada.

The Award

The award shall consist of an appropriate certificate and $400. The scholarship should be presented during National Science and Technology Week, in a way that promotes College Chemistry Canada. If geographically possible a C3 executive or board member should make the presentation, otherwise a C3 member in good standing may present the award.

Nomination of Candidates

The candidate must be nominated by a C3 member in good standing. The nomination must be submitted in writing to the secretary (or other executive member) by September 30th of the year the award is to be presented. The nomination should include a letter of recommendation and supporting evidence such as transcripts.

Selection Committee

The selection committee shall consist of the members of the executive, excluding any member who has nominated a candidate. If more than one executive member must be excluded they should be replaced by a regional director.

Selection Criteria

As C3 encompasses many different types of institutions it is difficult to provide clear-cut guidelines for selection of candidates but the following factors should be taken into consideration.

The candidate should be entering into, or continuing with a chemistry related area or program. Some examples might be: a student who has completed the first year of a university transfer program in sciences and will be continuing with a second year, a student who is part way through a chemical technology program, a high school student who will be entering a college in a chemistry related area.

Academic merit will be considered but will not be the sole deciding factor.

Participation in student organizations will be considered - e.g. Student Chapters of the C.I.C., volunteer work with local science centres or schools, participation in local science fairs (either as a entrant or judge)

Hope your semester was successful and wishing you a relaxing holiday season!

Suzanne (Gardner) Pearce

Environmental Chemistry - a status report

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by persistent toxic organic chemicals such as pesticides, are both topics that have always received substantial attention in environmental chemistry courses and textbooks. Of late, the problem of how to deal with Wastes - both hazardous and not - has received more prominence, as has the issue of how chemical industry can adopt practices so as not to produce wastes in the first place. The area of analysis and remediation of sites polluted by various chemicals seems to be one of potential employment for many graduates.

The analysis of environmental samples is central to the practice of environmental chemistry, although it can be difficult to address at the undergraduate level. In the mid-1980s, Martin Stillman, King Wong and Ron Martin at Western devised innovative new analytical chemistry undergraduate lab courses with an environmental orientation and which incorporated high tech lab equipment such as HPLC, Ion Chromatography, Flame Atomic Absorption, etc. that students actually acquire hands-on experience in using. Other universities have followed this lead in providing state-of-the-art analytical environmental instrumentation in their courses.

As a sign of the acceptance of Environmental Chemistry into the mainstream of the subject, it is relevant to note that in 1994 the American Chemical Society established criteria for approving undergraduate environmental chemistry programs. Several have now indeed been approved; for an example, see the article in *Environmental Science & Technology* volume 29, p. 130A (1995).

In the late 80s and early 90s, we found that a number of our Science undergraduates were informally combining existing environmental courses, offered by various disciplines, in a effort to "major" in environmental science here at Western. As a response to this student demand, a formal undergraduate program in the area was constructed, mainly with pre-existing environmentally-related courses in biology, geology, statistics and geography as well as chemistry. In addition, two one-term interdisciplinary courses - in which chemistry plays a strong role - were created to fill out the student's background and experience. Most importantly, we created **combined** majors and honours programs which allowed students to study a traditional discipline such as chemistry (or biology or geology) plus the environmental science program so students could pursue both simultaneously. These combined programs - especially that with biology - have proven to be the most appealing to our students. The total enrollment in these programs, relative to that in the Faculty of Science as a whole, rose rapidly and has now reached a steady state. Currently we are experiencing some decline in the popularity of the chemistry combination, but increased popularity in that with geology.

Many of the major universities in southern and central Ontario now have undergraduate Environmental Science programs on their books. The emphasis on the various traditional disciplines within these programs varies from one university to another; thus the standardization of course loads that one finds, for example, in the Honours Chemistry programs when different campuses are compared does not exist in the Environmental area. The programs themselves range from ones labelled "Environmental Chemistry" or "Atmospheric Chemistry" to some Environmental Science programs in which the chemistry content is slim indeed. There is often a lack of standardization even within a given university's programs (including ours at Western), since there are usually choices given of the "take one of the following set" type. Whether this is a good thing or not overall is not clear; it does allow the student to follow his or her interests but it can leaves employers wondering just a student with an environmental degree from University X really has taken.

Because Environmental Science programs at universities usually do not provide much "hands-on" practical training, student interest has grown in following a B.Sc. degree with a one- or two-year post-baccalaurate diploma program at a community college. For example, two students who graduated from Western this past year with 3-year general degrees in Environmental Science are pursuing such an option - one in the Environmental Science diploma program at Capilano College in North Vancouver, and one at Niagara College, where there are programs in Environmental Management, Ecosystem Restoration, Environmental Assessment, and GIS to choose from. As well, the new Royal Roads University in Victoria offers students with two years of undergraduate work elsewhere a continuous 12-month program that culminates with a rather practical B.Sc. in Environmental Science. On the other hand, many of our students at Western who have pursued the full Honours-level joint degree have subsequently entered graduate work. In short, there is a growing tendency for students to pursue training beyond the simple university degree.

Some of the young people graduating from Environmental Technology and similar programs at community college have expressed interest in continuing their education at university, since they realize that they need a degree to get ahead. At Western we have begun an experiment that responds to these needs by granting such students a number of transfer credits toward a 3-year B.Sc. in Environmental Science, which they normally can complete in one calendar year.

In summary, Environmental Chemistry seems to be accepted as a common though not universal option now at many Canadian universities, and in many cases environmentally-oriented B.Sc. programs incorporating both chemistry and environmental science have become available. Although public interest and government funding into matters environmental has declined in the very recent past, many observers believe that a new, maturer phase has been reached in which environmental values have been established and incorporated on a widespread basis by the public. Corporations are implementing the principles of sustainable development and "green chemistry" into their everyday practices. Correspondingly, environmental aspects of chemistry are being incorporated into individual courses and programs.

Teaching Environmental Chemistry

by Dave Warwick, Northern Alberta Institute of Technology

A well known TV science personality once said that when he embarked on a career in environmental education his first thought was for where he was going to find information on environmental topics.

Upon entering this field his dilemma quickly became what to do with the mountain of information available. That, too, is one of the challenges for the teacher of environmental chemistry.

If you are developing a new course in environmental chemistry then clearly the topics chosen for inclusion should be in the context of the diploma or degree program in which the course is to be taught. Presumably, the program, in turn, is designed to meet some particular societal need. Thus, an environmental chemistry course for biological science students will probably differ from an environmental chemistry course for engineering students. These differences should reflect the particular needs of each program and not teacher bias. Anyone who has taught environmental chemistry knows how difficult it can be to avoid spending a disproportionate amount of time on a favourite topic or area of expertise.

Teaching environmental chemistry to students, whose primary field of study is chemistry, offers a marvellous opportunity to bring chemistry to life and relate environmental chemistry issues back to some erstwhile theoretical concepts learned in earlier pure chemistry courses. We are continually reminded of the need for reinforcement in the learning process. One of the great things about teaching an environmental chemistry course is the opportunity for reinforcement. If I may quote from David Humphrey's excellent article in the C_3 News, Winter 1996 issue: "We need to give more attention to the significance of the content." Teaching environmental chemistry allows us to do this, in a kind of reverse sense. Choose any currently recognized environmental chemistry topic and you can relate it back to a number of basic chemistry principles, thereby providing the student with a new contextual understanding of basic principles previously learned. This is an approach I have used at NAIT and the benefits to the student are as follows:

1. Basic chemical principles become more relevant to the individual student and the interest in chemistry per se rises to a new level.
2. Students gain a better understanding of some ways in which chemical principles play out in the real world.
3. Reinforcement of chemical principles. Though a student may have underachieved academically, by the evaluation criteria laid out in an earlier chemistry course, it is still important to revisit a chemistry concept or principle. There may be no marks for any new understanding of the principle, when explained in an environmental chemistry context, but there is more to teaching chemistry than just the lecturing and evaluation processes.

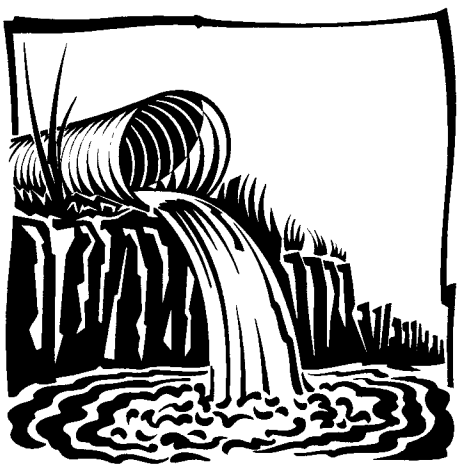
One of the questions most frequently asked by students of environmental chemistry is "How do I get a job in the environment?" This question has a number of possible answers. However, if we have done a good job of teaching environmental chemistry by continually helping the student relate chemical principles to each environmental topic, then the student question becomes more specific, for example, "How do I get a job in the field of bioremediation?"

I have used a couple of other methods, in the form of assignments, to help students focus their minds on the subject and give some serious thought to environmental issues, beyond the regurgitation of facts for marks. Neither type of assignment is revolutionary in concept, yet, if properly applied by the teacher, can produce some serious individual effort from the student.

The first assignment is a term paper on an environmental topic of the student's choice. The student response should include a statement of why they chose the topic, a clear explanation of chemical principles involved, and finally, a brief discussion of why this topic is important.

The second assignment relates to environmental films and videos. One thing I avoid doing, if possible, is showing a film in class. Occasionally I will show a film that has good technical content. However, most environmental films have too much of a sociology approach to warrant taking up valuable class time in an environmental chemistry course. In any case, showing a film in class reminds me of the occasional day in secondary school when a substitute teacher appeared in class and we knew right away that nothing stressful was going to happen for the next hour. My approach is to give my students a list of films and videos that I know are available to them at the NAIT library. I assign them to choose one of the films, view it in their own time, write a summary of the content, evaluate it on a scale of zero to ten, and explain why they evaluated it the way they did.

Clearly there are different ways that environmental chemistry can be taught. More and more students have access to environmental information through the internet. They can, in minutes, tap into that mountain of information referred to earlier. In spite of the technology aids available to students and teachers, I believe there is still room for, and a need for, good old fashioned student teacher face to face interaction, and hence a need for good teaching skills. If not, then we have to get into the bigger discussion of the overall role of a teacher in the modern world of electronic delivery of information.



The Chemistry Stream in Environmental Science at Sir Wilfred Grenfell College.[1]

by Julian Dust, Sir Wilfred Grenfell College

This spring Convocation at Sir Wilfred Grenfell College (SWGC) will see the first graduating class of the Memorial University of Newfoundland (MUN) B.Sc. degree in Environmental Science. The approximately 35 graduands will be drawn from one of two Streams: Chemistry or Biology. These Streams focus on the application of the parent sciences to the environment and provide depth in the program. Currently, about 100 students have declared their intention to complete the Environmental Science Specialization at SWGC.

From a distance, the program is structured after the U.S. Liberal Arts and Science tradition[2] in that all undergraduate degrees at SWGC require completion of a Core of (six) General Education courses, drawn from categories that roughly correspond to Fine Arts, Humanities, Social Sciences and Physical/ Natural Sciences. The College Core has further provisions designed to encourage numeracy, literacy (i.e., ten designated Writing courses that derive from the "writing across the curriculum" concept) and a broad appreciation of issues in science; the last requirement is met by completion of a specially designed two course sequence. Generally, requirements of the Environmental Science program and the SWGC Core overlap. For example, students in both Streams complete a 1st Year Mathematics sequence and, consequently, also fulfil part of the SWGC numeracy requirement.

A typical progression of courses for a student pursuing the four-year General degree is shown in Table 1, while the alternative fourth year courses for the Honours degree are listed in Table 2. These Tables show only one possible pathway through the program.

Concentrating on the Chemistry Stream, it can be seen that the first two years of the program are similar to standard chemistry degrees. Hence, students may complete up to two years of a MUN science program at SWGC before electing to joint the SWGC Environmental Science program.

continued on next page

Table 1. General B.Sc. degree in Environmental Science (Chemistry Stream) at SWGC.

Year 1	Year 2
General Chemistry 1,2	Intro. Organic Chemistry 1,2
Calculus 1,2	Intro. Physical Chemistry/Intro. Inorganic Chemistry
Physics 1,2	Statistics/Survey of Environmental Chemistry (ENVS 2261)[a]
English 1,2	Biology 1,2
Electives 1,2	Elective 3 /Energy and the Environmental (ENVS 2430)[a]
Year 3	
Environmental Analytical Chemistry 1,2 (ENVS 3210, 3211)[b]	
Industrial Chemistry (ENVS 3260)/Atmospheric Chemistry (ENVS 3261)	
Science 3000/3001[b]	
Transport Phenomena (ENVS 3470)/Ecology (Biol 2600)	
Electives 4,5	
Year 4	
Aquatic Chemistry (ENVS 4230)/ Research Project 1 (ENVS 4950)	
Organic Chemistry of Biomolecules (ENVS 4240)/ Elective 8	
Environmental Ethics (Philosophy 2809)[c] Elective 9	
Elective 6/ Environmental Policy (Political Science 3731)[c]	
Elective 7/Environmental Science Seminar (ENVS 4000)	

[a]Chosen from a list that also includes Remote Sensing (Environmental Studies 2000), Geological Hazards (ENVS 2360), Global Environmental Change (ENVS 2370), Oceanography (ENVS 2371), Meteorology (ENVS 2450) and Comparative Marine Environments (ENVS 3072).

[b]College-wide Science Concepts/Issues requirement.

[c]Chosen from a list that also includes Cultural Crises and the Environment (Anthropology 3083), Economics 2010 (Intro. Microeconomics), Environmental Economics (Envir. Studies 3000), Politics and the Environments (Political Science 3550) and Spirtuality and the Environment (Religious Studies 3880).

The Chemistry Stream in Environmental Science

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There is one important difference between a standard second year selection of courses and the program; in the second year the student completes the first environmental chemistry course, the Survey of Environmental Chemistry (ENVS 2261). This course provides an overview of environmental chemistry. Several texts are suitable for the course, including those of Nigel Bunce and Colin Baird which both have significant Canadian content. We are currently using *Environmental Chemistry* by Colin Baird and have had good feedback from the students concerning the appropriateness of the text at the second year level. Where some environmental science programs leave off — with a single environmental chemistry "add-on" — our program begins: with a survey of the important current topics in the field.

Moreover, environmental science students of both Streams take a selection of interdisciplinary courses (minimum three) as well as two courses from a set of social science and humanities offerings. Altogether these parts of the program constitute the Environmental Science Core that ensures breadth in the program.

We strongly feel that the ESC is integral to the program. It permits students flexibility in pursuing their environmental interests. At the same time the social science-humanities component helps put the science into focus. In our view a proper environmental science program cannot neglect this facet of learning.

From their third year of studies onward students in the Chemistry Stream take lab-oriented courses in Environmental Analytical Chemistry (ENVS 3210 and 3211) and Aquatic Chemistry (ENVS 4230) that emphasize not only wet-bench (dissolved oxygen, specific ion electrode, etc.) and instrumental (GC, GC-MS, FT-IR, UV-Vis and AA spectroscopic) methods of analysis but also sampling. The Industrial Chemistry course (ENVS 3260) delves into the applications of physical, organic and inorganic chemistry to industry, compares different processes (e.g. LeBlanc vs. Solvay process for sodium carbonate) and examines the special waste disposal problems associated with sectors of the chemicals industry (e.g. the highly coloured effluent from dye factories). The course includes talks by guest speakers and tours of local industries. In Fall 1996 the class listened to a guest lecture of Dr. Geoff Rayner-Canham about cement chemistry, followed by a tour of the local *Northstar Cement* plant.

Honours students also complete two courses from a set comprised of advanced Environmental Organic Chemistry (ENVS 4249), advanced Aquatic Chemistry (ENVS 4239), Groundwater Flow (ENVS 4479) and Fundamentals of Soil Systems (ENVS 4069). A two-semester research project is a requirement for achievement of the Honours degree, along with maintenance of MUN standards for Honours.

In many senses environmental science is a discipline undergoing definition. A possible definition is: Environmental science is the discipline that applies aspects of biology, chemistry, geology and physics to the understanding of the interactions of humans with the natural environment and seeks to reduce, remedy or mitigate the negative consequences of these interactions. The need for some depth in environmental chemistry, some exposure to ecology, earth science and environmental physics, is apparent if we are to define a pristine environment, recognize a polluted venue and apply

chemistry to the remediation of the site. The need for the social science-humanities component is apparent the moment we consider the multi-faceted interaction - political, social and ethical - of humans with their environment.

In May 1998 we graduate our first Environmental Scientists. They will help us refine our definitions and our program of study.[3]

Table 2. B.Sc. Honours degree in Environmental Science (Chemistry Stream) at SWGC.

Year 4
Organic Chemistry of Biomolecules (ENVS 4240)/Environmental Organic Chemistry (ENVS 4249)
Aquatic Chemistry (ENVS 4230)/ Groundwater flow (ENVS 4479)
Research Project 1, 2 (ENVS 4950, 4949)
Environmental Science Seminar (ENVS 4000)/Elective 8
Electives 6,7

References and notes

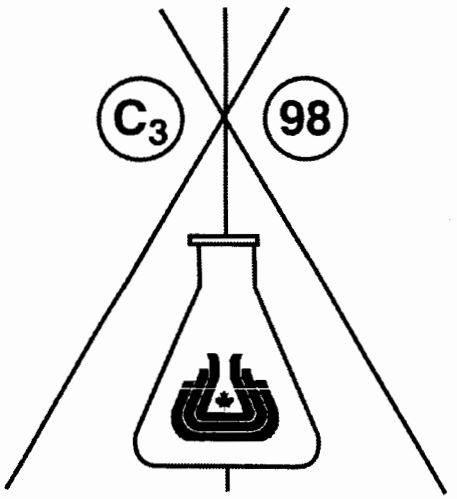
1. Given, in part, at the joint C_3-2YC_3 Conference held at Sir Wilfred Grenfell College, June, 1997.
2. G.W. Rayner-Canham and M.F. Rayner-Canham. "Chemistry Teaching in US Liberal Arts Colleges." *Education in Chemistry*, **25**, 148-150 (1988).
3. Further information see: http://beothuk.swgc.mun.ca/envs/Crslst.htm.

A warm welcome awaits you in southern Alberta

The organizing committee for the 25th College Chemistry Canada Conference invites you to visit southeastern Alberta, the city of Medicine Hat, and the Medicine Hat College, May 28 to 30, 1998. This portion of our great country is home to antelopes, rattlesnakes, black widow spiders, scorpions, and a number of chemists working in industry, research, and education. Although we cannot promise that you will see any of the wildlife, we can promise papers, workshops, and fun times to make your trip worthwhile.

The theme of the 25th C_3 conference is "Chemistry under the tepee," which will provide us the opportunity to highlight some of the important chemistry that takes place here in the community. The conference will get underway on May 28 with the traditional wine and cheese - always a great way to meet with old friends, and make new ones.

The Medicine Hat College Campus, site of the 1998 C_3 conference



Friday will see individuals present talks on some of the chemical processes and products manufactured in and around Medicine Hat (which will hopefully include Canadian Fertilizers Limited, Methanex Corporation, Catalyst Recovery Canada Ltd, and Cancarb Limited), as well as chemical and biochemical research conducted at the Defense Research Establishment Suffield. In the evening we have a banquet planned, to be held at a local golf and country club, offering fine dining and one of the best views of the city.

Saturday morning will start with the fun run through the coulee that runs adjacent to the Medicine Hat College, followed by presentations on chemical education, chemistry on the internet, chemistry videos, and computers in the laboratory. Saturday evening will be left open for participants to explore the city, with its numerous parks, restaurants, cafes and pubs.

For those remaining in the city on Sunday, look forward to an opportunity to golf at a selected course, or take a trip to one of the nearby attractions, such as the Cypress Hills (including the N.W.M.P. post at Fort Walsh), or the Royal Tyrrell Museum in Drumheller. Keep watching for further details, and plan on attending the 1998 C_3 conference in Medicine Hat (Or better yet, plan on *presenting* and attending!)

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You can keep up to date on conference details by visiting us at our website at http://www.c3conference98.com.

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