

An Evolving
TEN YEAR ACADEMIC PLAN

Earth and Ocean Science
University of British Columbia

REPORT OF THE AD HOC COMMITTEE
ON VISION AND HIRING

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Introduction

The Department of Earth and Ocean Sciences was formed in spring 1996 by merger of the departments of Geophysics, Geological Sciences and Oceanography. Three atmospheric scientists joined EOS in the spring of 1999. The creation of the new unit stemmed from the realization that the limited size, physical separation and distinct curricula of the former departments presented subtle barriers that constrained research collaboration and that limited new initiatives in undergraduate and graduate teaching in critical scientific areas.

This report is the result of a process begun in 1999 and is subject to continuous revision in response to changing circumstances. First, a vision of the Department was distilled from our perception of the evolving frontiers of earth sciences and our obligations to the community. We specifically considered structure, new directions, the learning environment, technical facilities and support staff. From this exercise we assembled guidelines to be used when hiring new faculty or during the annual revision of the hiring plan. Finally, we developed our current hiring plan together with rationales that reflect our concept of the type of research and researchers needed to consolidate UBC's position as the best place in Canada for studying the Earth and its evolution.

For reasons of efficiency, we use the term *earth sciences* as a collective reference to the earth, ocean and atmospheric sciences.

<p>The Evolving Planet Paleoclimate Tectonics Global change</p>	<p>Chemical Processes Chemical/phase reactions Transport phenomena Chemical cycles</p>	<p>Mathematical Methods Inverse theory Time series Physical modelling Numerical modelling</p>
<p>Fluid Dynamics Atmosphere Oceans Core Groundwater Cryosphere</p>	<p>Mapping and Characterization Mapping and measuring Remote sensing and imaging Chemical and physical properties</p> <p>Biological Processes Biological oceanography Microbiology</p>	<p>Natural Resources and Hazards Drugs from the sea Mineral deposits Hydrocarbons Groundwater Landslides Toxic blooms Fish</p>

Fig. 1. Research strengths of the Department of Earth and Ocean Sciences.

Current research strengths of EOS are summarized in Figure 1. With few exceptions, these research foci are common to both the solid-earth and environmental-earth sciences. From this recognition, a new conceptual model for EOS (Fig. 2) was adopted in which Earth Evolution and Global Change become central linking themes. We believe that this model captures well the structure of EOS, and presents a template for future planning.

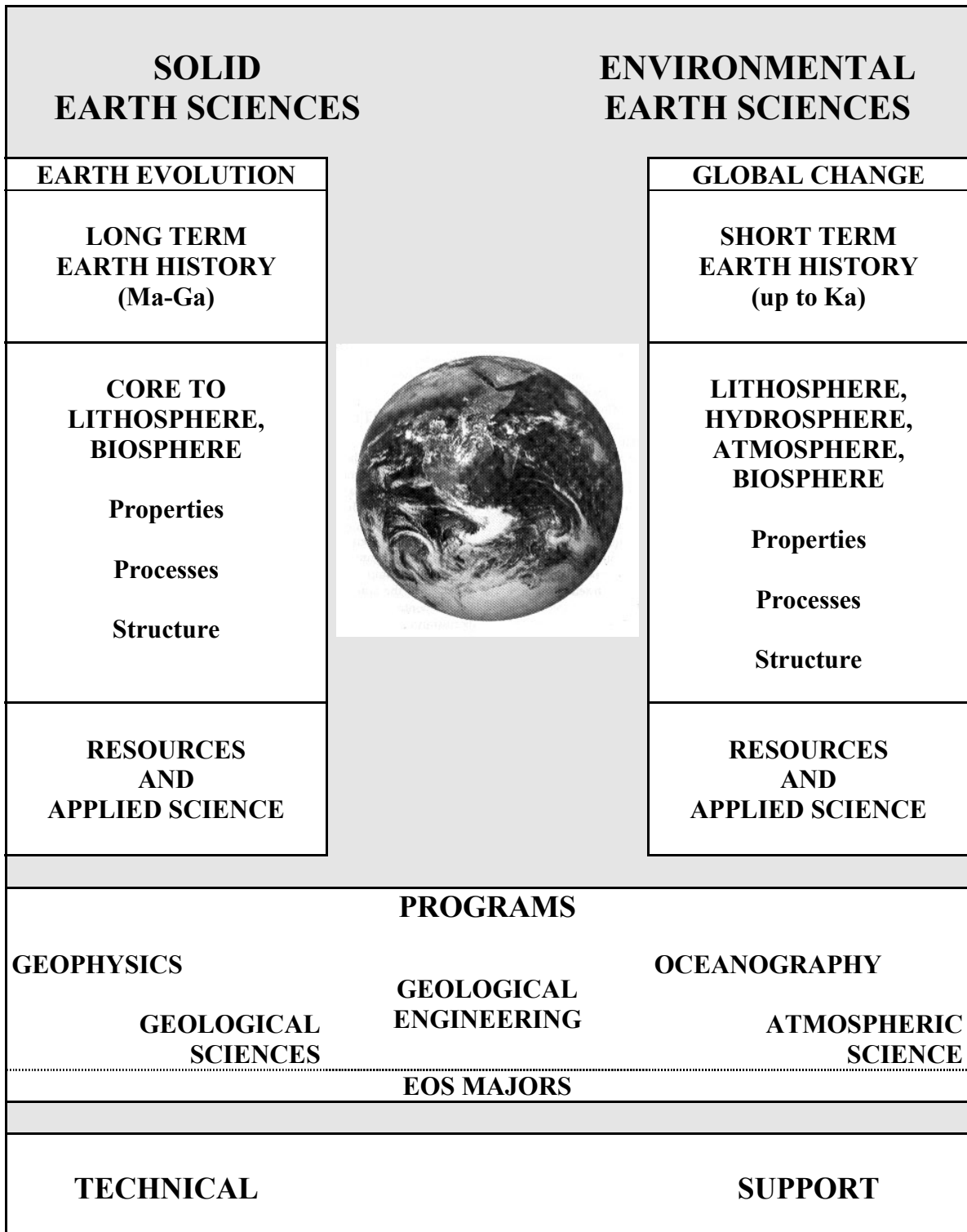


Fig. 2. Conceptual Model of the Department of Earth and Ocean Sciences

◆ The Future: Key Issues

This plan identifies the following priorities for the development of EOS: (i) balance; (ii) connectivity in research; (iii) connectivity and expansion in the scope of teaching; (iv) nurturing links with the community; and (v) enhancing technical facilities. All of the foregoing are currently being addressed but we emphasize that housing EOS in a single building, with properly-equipped classrooms and suitable research infrastructure, would constitute the single most effective step toward realizing these objectives.

While recognizing that the current breadth of EOS is a strength that we must vigorously defend, it is apparent that we cannot cover all aspects of the geophysical, geological, oceanographic and atmospheric sciences. The model of the Department shown in Figure 2 illustrates the balance that we intend to strike in the future. Collectively, we need to know how the earth works and evolves. The solid earth sciences are a natural grouping that focus on evolution of the earth's core to lithosphere on time scales typically measured in millions of years. The environmental earth sciences are concerned with processes operating near the surface of the earth over time scales ranging from seconds to thousands of years. To be a viable department that can meaningfully contribute to the study of earth structure and the processes that lead to short term global change and long term earth evolution, it is essential that we maintain a balance and explore the connections within and between the solid and environmental earth sciences.

Valued links between the former departments and the community have grown over the years because of our geographic position in a resource-rich, seismically active, coastal area. We should protect and nurture these links.

The five honours programs listed in Figure 2 are the foundation of our undergraduate teaching. The programs must, of course, evolve if they are to maintain their vitality and we see the development of courses that cross traditional subject boundaries as being catalysts to this evolution. In addition, there is a sizeable undergraduate constituency interested in the earth sciences from a cultural rather than a professional perspective. Our newly formulated majors program, which embraces the full spectrum of earth, ocean and atmospheric sciences, should effectively cater to this group. The program will be launched in September 2001 and the Public and Internal Relations Committee has been charged with promoting this program throughout the university and in the schools.

Geological Engineering is a program that is properly rooted and nourished in the Earth Sciences, while being largely motivated by problems from the engineering world. As such, the program provides a critical connection between the scientific understanding developed in EOS, and practical problems in applied science. Furthermore, its existence at the interface between the Sciences and the Applied Sciences is a source of its vitality and unique perspective. The strength of the Program rests firmly upon continued insights developed within EOS and we strongly believe that to ensure its continued vigour, the Geological Engineering Program should be maintained within EOS. Feeding new science into engineering is a challenge that is best met under the umbrella of the current structure. EOS must constantly redefine the Earth Sciences "canon" as new insights demand and must ensure that these developments are clearly communicated to professional certification bodies.

Technical facilities are fundamental to any research-intensive organization. Shared, widely-used facilities, whether they be analytical instruments or computational resources, serve as a powerful cement that binds the once separate constituencies of EOS. In the past, equipment has often been obtained through the efforts of individuals or small groups but we now have the opportunity to assemble large proposals benefiting a spectrum of scientists across the solid and environmental earth sciences. The recent success of CFI proposals to establish the Pacific Centre for Isotopic and Geochemical Research and the Geophysical Disaster Computational Fluid Dynamics Centre demonstrates that multiplied benefits provide a strong basis for winning proposals. We must continue to take advantage of such opportunities to maximize our chances of success in grant competitions and to enhance the likelihood of obtaining necessary technician support.

◆ **The Future: New Directions**

The earth sciences, positioned at the intersection of the mathematical, computational, physical, chemical and biological sciences, are innately multidisciplinary. Earth's structure and environment have evolved continuously for 4.5 Gyr and this adds an historical dimension to the science. The scale of earth systems can be huge and the process rates slow. Thus, unlike canonical sciences, such as physics, the possibility of rigorous experiment is often denied yet, like astronomy, the science is not soft and much of it has urgent relevance to humanity. The central concerns of the earth sciences are the state, history, processes, evolution and future of planet Earth and its surface environment.

EOS is in the fortunate position of being able to offer education and research opportunities that address these concerns. The rapidly growing recognition of connections and feedbacks between and among earth systems, and the concern that human activities are influencing these at a rate which is surely accelerating, presents EOS with what is both an unparalleled opportunity and an extraordinary challenge. From the pedagogical perspective at both the undergraduate and graduate levels, the opportunity is that the workings of internal, surface and atmospheric earth systems can now be illustrated by an exceptional number of examples. These can be drawn not only from traditional empirical observations but from the new frontiers of remote sensing and numerical modelling. The challenge is to convey the excitement inherent in these new fields while simultaneously fostering an appreciation of the degree to which earth systems are coupled. From the research perspective, the opportunity lies in taking advantage of multidisciplinary initiatives designed to discover what constitutes the connections and what drives the feedbacks. The challenge is one of participation: to ensure that our graduate students in both science and engineering are exposed to the breadth and depth of current earth systems research while at the same time receiving training at a level sufficient for them to take the fullest possible advantage of the evolving frontiers.

We see the challenges and opportunities as dictating the academic philosophy of EOS. Future hirings provide the principal mechanism by which the associated vision can be made concrete. Toward this end, two very broad hiring priorities have been identified. Both are consistent with the fundamental intention to foster connectivity within EOS. First, we must give consideration to hiring some established faculty known to be “big-picture thinkers”. These would be scientists who have become recognized for work that spans or even ignores traditional boundaries within and beyond the Earth Sciences. For

example, individuals who study the broad scale links between tectonic evolution, basin filling histories and hydrocarbon and ore deposit formation would fit the profile, as would scientists who explore the importance of biogeochemical cycles that drive global change by linking earth, ocean and atmospheric processes.

Second, the need to quantify scales and rates of earth-systems phenomena on the planet demands that we include in our collective research effort increasing emphasis on numerical modelling. The addition of modellers with a broad view of earth processes would strengthen, through collaboration, the research efforts of a considerable number of our existing faculty in, for example, atmosphere and ocean dynamics, tectonophysics, metamorphic processes, climate change, seismology and biological systems in the oceans.

Remote sensing is recognized as an important technique of modern earth-systems and global-change research. Rather than place emphasis on this within an EOS hiring plan, however, the committee feels that the department would receive maximum immediate benefit by collaborating more closely with physical geographers, for whom remote sensing is an integral research tool. Thus, the commitment to house the Department of Geography in the planned new EOS Global Learning Centre is an important step in fostering what would surely become a productive cross-faculty research collaboration in the physical earth sciences. If progress toward the new building remains stalled, the role of remote sensing within EOS should be re-examined.

EOS can connect to the broader campus community of applied scientists through the Geological Engineering Program. While EOS is at the centre of research that supports the environmental, geophysical and exploration options of Geological Engineering, the geotechnical expertise is considerably more dispersed on campus, and the geotechnical group feels particularly isolated. EOS should encourage a tighter link between the geotechnical group in EOS and other geotechnical research groups on campus found in the Geography, Civil Engineering and Mining Departments. An ideal mechanism may be to cross-appoint new hires to allied departments, or to create an umbrella organization to consolidate geotechnical-engineering research and course offerings on campus.

◆ **The Future: Need for the EOS Global Learning Centre**

In 1994, the University of Toronto recognized in its Planning White Paper the critical importance of physical proximity of faculty in a given research and teaching unit:

“It is possible for single scholars or groups of scholars who are at some physical distance from each other to come to constitute, through continual exchange, a node within a broader network. Nonetheless, most scholars flourish in a supportive environment that includes the physical presence of others in their field or in closely related areas. Information technology enhances but does not replace on-going patterns of academic exchange that include face-to-face contact. Daily exchange – over coffee or lunch, or even in the elevator, as well as in the laboratory, the library, or the seminar – allows for a spontaneity and serendipity that mediated communication is less likely to achieve.”

Until Fall 2000 the faculty of Earth and Ocean Sciences at UBC were spread among five buildings. The relocation of the atmospheric scientists to the Geological Sciences building reduced this number to four. This minor success will be short-lived because the new EOS-led Pacific Centre for Geochemical and Isotopic Research (PCGIR) will be housed in the Chemistry building. Although all EOS faculty are within a five-minute radius on foot, opportunities for the serendipitous contacts that are so important to generating synergy in research are severely inhibited by the existing physical separation. This separation also makes it difficult to plan for shared major equipment and technical facilities. Furthermore, the locations of the former departments of Geology, Geophysics, and Oceanography in their original discrete buildings or building groups reinforces historical cultures. This has prevented, and is continuing to prevent, full harvest of the fruit of the merger. To the extent possible, this shared problem is being addressed by the consolidation and reallocation of space in the Geological Sciences Building and the Geophysics and Astronomy Building but there is a limit to what can be accomplished by shuffling deck chairs. Interdisciplinarity, an important theme of the UBC Academic Plan, is not being realized within EOS to the extent it might were concentrated in the new EOS Global Learning complex. This situation is harming the academic progress of EOS and must be rectified.

The EOS Global Learning Centre would also house the UBC Earth Observatory which would serve as a public focus for EOS. The proposed observatory would bring together and extend the range of earth system observations conducted at UBC and provide an impressive backdrop for assorted community partnership activities as well as for topical interviews by press, radio and television journalists. The observatory would include instruments for continuous monitoring of earth tides, seismic events, geomagnetic variations and meteorological variables. Additionally, satellite observations of North East Pacific sea surface temperature, sea surface height, and atmospheric conditions would be displayed and continuously updated.

◆ **The Future: The Learning Environment**

Undergraduates enrolled in EOS have differing expectations of our programs that include some blend of: (i) preparation for employment as an earth scientist, (ii) preparation for entry to a postgraduate program in the earth sciences, (iii) acquisition of skills that can be translated as opportunities present themselves (e.g., numeracy, computer literacy, written and oral communication), and (iv) cultural knowledge. Items (i) and (ii) correspond to the traditional focus of science education whereas, increasingly, (iii) and (iv) correspond to the reality that many science graduates face. Without diluting our obligations to those students who seek careers in the earth sciences, we must work harder to serve and attract students who do not share this aim. Accordingly, we must adjust both the style and content of EOS course offerings.

We must avoid the pitfall of preparing young minds to meet the challenges of the past. We cannot presume to know which of the many areas of the earth sciences will, over the long term, be viewed as central and which marginal. Lacking this knowledge we must extend our commitment to flexible curricula, self-directed programs and permeable boundaries between disciplines. The sciences and the humanities are cultural expressions. In the case of the earth sciences, we cannot lose sight of the fact that science education need not be justified only in terms of research or employment objectives. If knowledge of

English literature is good for its own sake and part of becoming educationally-rounded, then knowledge of science must surely have comparable cultural value. Taking this point of view, we can examine existing and incompletely-realized strengths of EOS.

EOS and Its Potential

EOS at UBC is surely the most multidisciplinary science department in Canada. Yet we have been slow to establish a web of research connectivity and, until recently, have no undergraduate programs that vigorously exploit this potential strength. Arguably, the solid earth sciences are well-served by existing EOS programs, the environmental earth sciences less so. The July 2000 draft vision statement for EOS proposed that this issue be addressed: (i) By developing an honours program in environmental earth sciences. The new program might build on our existing strengths in low-temperature aqueous geochemistry, hydrogeology, surficial geophysical imaging, atmospheric sciences, and chemical, physical and biological oceanography. (ii) By developing an EOS majors program that encourages a broad exposure to all aspects of the solid and environmental earth sciences while allowing students to tailor their program to their own needs and interests. A new EOS majors program along these lines has now been designed and will be launched in September 2001. (A plan for achieving a 50% enrollment increase in EOS is presented as Appendix 1.)

In society as a whole, the polarities of resource exploitation and environmental stewardship tend to be viewed from an adversarial framework that can be simple-minded and counterproductive. Within EOS we have excellent scientists working on both sides of this divide. By developing courses and programs that focus on such complementary relationships we might provide a richer intellectual context for our undergraduates.

Undergraduate course offerings involve a multi-perspective mixture of: (i) object orientation (planets, atmospheres, oceans, plates, volcanoes, glaciers, ore deposits, petroleum reservoirs); (ii) method orientation (numerical modelling, time series analysis, chemical analysis); and (iii) issue orientation (global warming, water quality, raw materials, energy resources). Some, though not all, of our undergraduates are drawn to EOS by *issues* rather than objects and methods.

Education and Employment

EOS is justly proud of the fact that the majority of graduates from undergraduate EOS programs, especially those in the solid earth sciences, find employment as earth scientists. Many of these eventually seek professional registration, either as a Professional Engineer (P.Eng.) or Professional Geoscientist (P.Geo.) and this consideration places constraints on our programs. It is reasonable for undergraduates in the EOS Geological Engineering program to expect that program to be accredited by the Canadian Engineering Accreditation Board of the Canadian Council of Professional Engineers. The cost to EOS of this bargain is to surrender some control of our curriculum to an external body. The situation with respect to P.Geo. registration is more flexible but we must continue our constructive dialogue with The Association of Professional Engineers and Geoscientists of British Columbia. It is essential to promote the idea that the earth sciences are multidisciplinary and continually evolving and that narrowly-prescribed curricula will have destructive impacts.

The success of Co-op programs at the University of British Columbia and other Canadian universities is an established fact. In addition to nurturing the existing Atmospheric Science and Geological Engineering co-op programs, we are broadening this effort to include the solid earth sciences and will launch this new co-op program in September 2001.

Education and Research

Increasingly, UBC proclaims itself as a “research university”. EOS applauds this stance, in part, because it implies a clear distinction between the societal obligations of a major university and those of a college. An essential responsibility of research universities, at least those having undergraduate programs, is to ensure that undergraduate education is enriched and informed by that university’s research activity and, to the extent possible, that undergraduates share in the excitement of this activity. Based on current enrollment in EOS, almost 75% of our B.Sc. graduates are in honours or combined honours programs and will therefore complete graduating theses. Thus one of the stated university objectives of integrating teaching with research is already being met for the majority of our graduating students.

As confirmed by many exemplars within EOS, excellent teaching and excellent research go hand in hand. Established or potential research excellence will remain an essential criterion for hiring tenure-track faculty. Excellent researchers who lack the ability or commitment to become good teachers place unfair burdens on their colleagues and should not be considered for tenure-track positions.

Education and Information Technology

The largest computer in Canada today, located in Dorval, is dedicated to simulating the dynamics of Earth’s atmosphere, and seismologists were among the first voracious users of the earliest digital computers. Indeed UBC’s great benefactor, Cecil Green, was a seismologist who foresaw the transistor revolution and, in so doing, fathered the high-tech empire of Texas Instruments. In short, computers and earth scientists have been inseparable for decades; our appreciation of the costs and benefits of this relationship is based on long experience.

Educational Information Technology (IT) impacts EOS undergraduate courses both in the classroom and in course management. Curiously, despite the high level of computer literacy possessed by most EOS faculty members and the essential computational underpinnings of much of the undergraduate curriculum, actual usage of computers in the classroom is low. There is no question that many EOS faculty are frustrated by the logistic difficulty of illustrating lecture material using convenient tools like MATLAB and those who are least frustrated are likely to have solved the problem by employing *research* computers and software (i.e., NSERC-funded rather than UBC-funded). A substantial investment in software, computing equipment, ultra-fast (e.g., 1 Gbit/s) network hookup, projection facilities and technical support are still required. However, we are encouraged by recent improvements such as the University Networking Project (100 Mbit/s) and the Academic Equipment funding of EOS computer projection hardware.

Until recently, the situation with respect to EOS course management was bright. Thanks largely to the energy and enthusiasm of a single individual, EOS faculty have been early to exploit WebCT in support of undergraduate courses. The departure of this individual exposes the double-edge of EOS's commitment to instructional IT: to the extent that EOS faculty have become adept at using WebCT, a long-term benefit can be foreseen; to the extent that EOS faculty depended on the skills of a single person to maintain this capability, the investment is in jeopardy. Any commitment to instructional IT must be a sustained one or no lasting benefit can be realized.

Education and the Physical Environment

The EOS Learning Environment is only partly separable from the EOS Physical Environment that is reflected in the corridors, classrooms, laboratories, offices and washrooms of our thinly-spread enterprise. A new building to house EOS is a high priority but, at best, offers a long-term solution. From an immediate perspective, the vision of a new building has been used to substitute for urgent and essential actions to maintain the spaces that currently house EOS. The Geophysics and Astronomy Building, scheduled for eventual demolition, is the most glaring example of this sustained neglect. At some level, it seems, a decision has been taken to stop maintaining this building. EOS must vigorously press the UBC administration for a serious commitment to upgrade and then maintain those spaces that house the Atmospheric Sciences, Geological Sciences, Geophysics and Oceanography constituents of a department that is greatly superior to the buildings that shelter it.

◆ The Future: Technical Facilities and Support Staff

Modern and well-maintained technical facilities, operated by skilled support staff, are essential to our research and teaching endeavours. Indeed, the Earth cannot be understood without quantitative measurements and analysis. State-of-the-art instruments, such as mass spectrometers, and conventional equipment, such as microscopes and precision balances, are important for research and teaching. To continue to have an impact on the Earth Sciences, it is crucial that EOS maintains and renews its technical facilities and supports the technical staff who are so critical to research productivity

Most research equipment in EOS is obtained through proposals to appropriate funding agencies. In this sense, the quality of our research equipment is a reflection of the strength of our research proposal arguments and the stature of our faculty. As leaders in their fields, our faculty will always be drawn to the newest and often most expensive instrumentation. To ensure efficient distribution of research dollars, funding agencies are demanding that researchers form co-operative groups to share major installations and to build critical masses of equipment and analytical expertise. EOS faculty members are linked by a web of common analytical methodologies that can be naturally organized into cooperative groups to attract research-equipment funding and make most effective use of technical staff.

EOS is the leading institution at UBC for instrumentation for the chemical analysis of Earth solids and fluids. Our mineralogical-analysis facilities include an electron microprobe, a scanning electron microscope, XRD and XRF instruments. Isotopes continue to be used to solve problems in almost every area of earth sciences. Our geochronology laboratory specializes in age-dating of rock samples. Our stable-isotope

mass spectrometers are focused upon carbon, nitrogen and oxygen isotope measurements. Our ICP-MS is used extensively for trace-element geochemistry. EOS should strive to build on this critical mass and consolidate chemical instrumentation for fluid analysis and solid analysis into aqueous and solid geochemistry laboratories. The Canada Foundation for Innovation underwriting of the Pacific Centre for Isotope and Geochemical Research has been an important step in this direction.

Networked high-performance workstations are an essential tool for much of the research conducted in EOS. As electronic technologies improve and decrease in cost, observations of the Earth rely increasingly upon automated and rapid data-acquisition systems, from simple data loggers to remote-sensing satellites. EOS must provide the technical facilities and staff to accommodate these inevitable advances. Modern and fast data networks must be provided to efficiently transmit and store large quantities of data. Presently, EOS networking is a patchwork of older cabling on several distinct sub-networks. Through the University Networking Project, the Geophysics and Astronomy Building (summer 2001) and the Geological Sciences Building (fall 2001) will be wired for 100 Mbit/s communication. This will improve the situation for some users but is considerably below the current 1 Gbit/s state-of-the-art and does not remove the need for substantial EOS investments in new cabling, routers and network switches.

While the acquisition of research equipment is principally the responsibility of the department faculty, the primary role of the university is to provide the infrastructure, buildings and people, necessary to both house and maintain our facilities in good working order. Sensitive instruments always require controlled environments. Chronic problems of poor room-temperature control and significant fluctuations in the main power supply have caused over \$60,000 damage to instruments in EOS in the last five years. Furthermore, our recent experience is that laboratory renovations done by university plant operations cost three to ten times more than they would if done by commercial, off-campus contractors. Excessively high costs consume precious research funding. In the most startling example, lab renovations costs estimated at \$300,000 in 1999 by a commercial architect have been estimated to cost \$2.8 million by university plant operations. It is important that properly equipped laboratory space be provided by the university at reasonable cost.

Our technical staff is crucial to ensure progress in our research investigations. Highly trained technicians are required to build, install, operate and maintain our equipment. EOS has been coping with a chronic shortage of technical-support staff, a problem aggravated by ten years of budget cuts which have come largely out of the technical-support budget. We are now at a point where our efficiency is being seriously compromised by long waits for, or a complete lack of, technical assistance. We must alter our balance of priorities to provide more funding for technical support staff. Many of our research technicians are grant-supported which gives them no security, and hampers our ability to retain top-flight people.

The importance of retaining highly skilled analysts for our scientific instrumentation cannot be overstated. Specialists are required to obtain reliable results in a timely fashion. For example, our mineralogical-analysis facility is one of the best in Canada due to the efforts of the director who is himself a leader in quantitative mineralogical analysis. The specialists who manage our labs are more similar to research faculty than technicians, yet

typically have relatively less secure appointments. EOS needs to consider creative strategies to retain these specialists, by providing secure career paths and opportunities to pursue research. EOS should also examine if it makes sense to create positions for specialists to direct our aqueous laboratories and our geophysical facilities. With these considerations in mind, an ad hoc Committee on Hiring Priorities chaired by Roland Stull recommended that two FT faculty slots be exchanged for technical and undergraduate teaching support. At the time of writing, these recommendations have been accepted and partially-implemented by EOS.

Hiring Philosophy

It goes without saying that the University has the responsibility to provide working conditions and remuneration that will attract the best candidates and that EOS must be supportive and provide an academically stimulating intellectual environment. Only in these circumstances can we attract and retain the best researchers.

If research excellence is our criterion, it is essential that our hiring plan be flexible enough to allow us to capture emerging or suddenly available talent. This is not to advocate ‘random acts of hiring’; all the hiring criteria listed here, as well as the long-term aims of the hiring plan have to be satisfied but when an exceptional opportunity arises, we must be willing and able to respond in a positive way. We must make it clear to the professional societies that our philosophy is to appoint the best researchers and teachers, not those who qualify for some criterion unrelated to their research abilities. In making this argument, we must press for flexibility on the part of the professional societies.

Scientific research follows fluid pathways whose destinations cannot be predicted. Nevertheless, we must continually reassess which pathways we wish to include in our collective research effort. There is little gain in the default position, that is, simple maintenance of the status quo. We also recognize that well equipped, multi-disciplinary research teams are best positioned to address the complex scientific questions of the new millennium. Consequently, we must consider ways to enhance connectivity between researchers, the broader research community and the community at large. In the context of the hiring plan, we must revisit, on at least an annual basis, the following questions:

- 1) How can we bridge between research areas?
- 2) How can we bridge between researchers within EOS?
- 3) How can we bridge to researchers outside EOS?
- 4) What areas should we be moving into or away from?
- 5) Are there any new technologies/techniques that we would like to see in EOS?

An appropriate venue for the discussion of these fundamental issues would be an annual departmental retreat. We recommend that such an event be built into our future planning.

Given the philosophy for teaching and learning described earlier in this report, we follow two simple principles that should act as primary influences in the future:

- 1) We should neither simply replace faculty nor consider positions to be the property of former departments.
- 2) There are teaching requirements to be met if we are to maintain a viable undergraduate teaching program. The current teaching needs of EOS should be made clear at the outset of any search. If the new hire is unable to meet these needs, EOS must have plans in place to deal with the problem before the hire is made.

A Flexible 10 Year Hiring Plan

Summaries of the expected schedule of retirements and departures and current and prospective hiring are tabulated in Appendix 2.

In addition, the Canada Research Chairs Program presents a double-edged opportunity for EOS. Firstly, UBC has decided that ‘Sustainability and the Environment’ will be a major cluster within the University’s CRC plan. The environmental earth sciences component of EOS and the numerical modelling approach to understanding earth systems both fall naturally into this cluster (see Appendix 3). Four EOS chairs are currently listed, three priority A (Oceanographic Processes and Ecosystem Dynamics; Global Process Modelling; Geomicrobiology) and one priority B (Geodynamic Process Modelling). Secondly, the recent external review of the Department emphasized the importance of hiring “big picture” scientists whose broad perspective is matched by a track record of interdisciplinary research. The Canada Research Chairs Program provides an opportunity to hire such senior scientists who would immediately become centres around which further appointments could be made.

We are doing at the entry and intermediate levels with regard to hiring women; this includes one recent success in the NSERC UFA program. The loss of Rosemary Knight leaves EOS without any females above the Assistant Professor level. We must address this deficiency by proactively searching for excellent senior women. The hiring of Dominique Weis is a very positive step in this direction.

◆ Short-Term Pool

Geophysical Processes – Observation, Modelling and Applications: EOS faculty in Geophysics have established international reputations in their specialty fields and developed world-leading research programs involving high caliber graduate students in an interactive, supportive environment. The fields of research include glaciology, geophysical inversion procedures, geodynamic processes of Earth’s deep interior, data analysis procedures, and structure/tectonics of the Earth’s lithosphere using controlled and earthquake sources. To enhance and complement the research foci in geophysics, while contributing to the integrated scientific breadth of our multidisciplinary department, we are looking for two outstanding geophysicists at the Assistant Professor level. The ideal applicant will represent the style and type of geophysical researcher required in the 21st century. She/he will be an exceptional young scientist who will focus

on modelling processes in the near-surface environment, the lithosphere and/or the upper mantle, or carry out innovative imaging of the earth with application to basic or applied problems. Without being exclusive, some examples might include: (1) multifaceted (seismic, electromagnetic, physical properties, etc.) studies of the near-surface environment; (2) development of innovative 3-d procedures in electromagnetic, seismic, potential field methods applied to exploration (e.g. petroleum, mineral or diamonds) or global studies; (3) modelling of tectonic processes from the lithospheric scale to that appropriate for exploration, environmental or engineering problems; (4) modelling of physical processes involved in magma generation and transport with application to mantle, crust or mineral deposits; and (5) physical processes associated with the development and evolution of Earth's surface (cryosphere, landforms, climate controls). Exceptional applicants at a more senior level may be considered. In addition to establishing a strong research program, the successful candidate would be able to teach courses in most aspects of geophysics at the undergraduate level and related to her/his specialty at the graduate level.

Engineering Geology: Remote Sensing, Rock and Soil Characterization: Engineering Geology is an interdisciplinary field which serves as a link between earth science and applied science. It is an important discipline, which ensures that scientific advances and insights are actually used to serve the society and protect the environment. As an interdisciplinary field, it is relatively young and full of exciting opportunities for original research. One of the greatest challenges of engineering geology is the physical characterization of rock masses and soils. Powerful geophysical and remote sensing tools are presently emerging for this purpose, but research is needed to improve their interpretation and to prepare them for reliable practical use. British Columbia is an ideal setting for research in this area, combining a natural laboratory with a need for new infrastructure fuelled by a burgeoning population. Proper ground characterization is essential for the cost-effective and environmentally safe design of tunnels, waste repositories, transportation corridors and many other facilities. The dollar values involved are spectacular. The local sky-train extension will cost \$1.2 billion, and geotechnical aspects will comprise about 15% of the cost. It is especially important to characterize weak rock and coarse soils, which are difficult materials to work with, and are largely neglected by the majority of soils-based geotechnical engineers. This position would link into established strengths in EOS in the areas of rock physics, applied geophysics, time-series analysis, inverse modeling, image processing, structural geology and slope stability. While firmly rooted in EOS, this position would be a conduit to carry science-based understanding to applications in applied science. Ideally, the candidate would be cross appointed to Civil Engineering, and have strong ties to the Geography and Mining Departments, thus linking the geotechnical group in EOS with the broader campus. The position would also fill a critical teaching and advising need in EOS in engineering geology.

Geomicrobiology: There has been a remarkable surge of interest recently in understanding the roles played by microbes in earth processes. These range from microbial fixation of carbon (chemosynthesis) in hydrothermal vents through the potential generation of hydrocarbons in the deep earth to the governance of oxidation-reduction reactions in groundwater, sediments, soils, and marine and lacustrine water columns. Microbial studies also figure prominently in biological oceanographic research

from perspectives of bacterially-mediated cycling of carbon in the sea, disease transmission and its ecological relationship with animal communities, and responses of the marine microbial community to changes on the planet induced by human activities.

We have a tremendous breadth of research programs in hydrology, geochemistry, biological and chemical oceanography and sedimentology in EOS that could benefit from microbiological insight. Thus, we are well placed in house to extract full collaborative value from the addition to our faculty of such expertise.

An appointment in this field will pay dividends in two other ways. First, Biology is sorely in need of extra teaching strength to help meet the burgeoning demand for the subject. Second, appointment of a microbiological specialist will reinforce links on campus to other departments (e.g. Microbiology) and research groups (in biotechnology and environmental engineering) as well as to the external community, particularly in the field of environmental consulting.

◆ **The Hiring Pool (2002-2011)**

The following list represents a pool of needs that must be revisited and modified every year to take into account the specific skill of previous hires, new scientific developments, resignations, and increases or decreases in the budget. During this exercise, priorities can be established and positions transferred to the short-term list. Gender equity has been and will remain an important consideration in future hirings.

We should try and renew shared positions in order to maintain our links with other departments, but when partial-position (rather than full-position) funds become available, we should use these to: a) hire technical support; or b) supplement other positions so that we can target more senior people.

Modelling Earth Systems, Earth Evolution and Global Change

Computer models have inspired a holism that is helping to reverse the fragmentation and reductionism that have characterized science in the 20th C. As computer models become increasingly complex, box models are rapidly being replaced by distributed models, and the demands for process faithfulness, rather than expedient parameterizations, become more urgent. Mere skill at numerical analysis is no longer a sufficient qualification for earth system modellers. Given this context, EOS requires three scientists who can collectively lead research in the areas listed below.

Global Process Modelling: This position is simultaneously the most important and least clearly defined of the proposed earth system modellers. EOS seeks an exceptional individual who possesses profound knowledge of atmospheric, oceanic, land surface and solid earth processes and their interactions. An expert in modelling global biogeochemical cycles might be a suitable candidate. Because scientific stature and leadership are essential qualifications for this position, it is unlikely that a ‘junior’ scientist could fulfill this requirement. The contribution to EOS teaching would depend on the particular expertise of the individual and should not be a determining factor in the selection process.

Global Change Science and Land Surface Process Modelling: Changes in the surface temperature, precipitation and wind fields activate changes in the rates and magnitudes of land surface processes that underlie such varied phenomena as desertification, permafrost degradation and sea-level rise. Earth system feedbacks and ecosystem modification can amplify the effects of such change. Accurate representation of land surface processes is an essential component of coupled climate models and, looking ahead, an essential component of ecosystem dynamics models. Conventionally, land surface processes have been the domain of geomorphologists and physical geographers who tend to deal mainly with observation and characterization. EOS seeks a scientist who combines these talents with the mathematical and computational skill necessary to improve the representation of land surface processes in global climate models as they become increasingly complex and detailed. Global change has been identified as a linking theme for EOS but, as yet, no courses reflect this point. A suitable candidate would be able to lecture in continuum mechanics, process geomorphology and global change science

Geodynamic Process Modelling: EOS has world-class expertise in modelling geodynamic processes of Earth's deep interior and requires a comparably-talented individual with expertise in modelling geodynamic processes of the upper mantle and lithosphere. Possible research foci include: (i) computer modelling of tectonic processes; (ii) modelling mantle dynamics and isotopic signatures; (iii) modelling interactions between geodynamic processes and processes of Earth's surface environment (ocean, atmosphere, land surface). Expert knowledge of seismology, as it pertains to scrutiny of geodynamic processes, is desirable. A suitable individual would be qualified to teach, at undergraduate and graduate levels, courses on continuum mechanics, seismology and tectonophysics.

Environmental Earth Sciences and Global Change

Sea-going Physical Oceanography: Physical oceanography is a core area within all research endeavour in oceanography, and from that perspective, the continued health of the physical oceanographic group at UBC is critical. More than that, however, is the recognition of the exciting role that physical oceanography is playing in global change studies. For example the World Ocean Circulation Experiment (WOCE) has been tracking the motions of the water masses in the ocean in an effort to determine where and at what rates intermediate and deep waters are forming. This joint venture between physical oceanographers and marine chemists is yielding highly important new information on the fate of fossil-fuel CO₂ that mixes into the ocean from the atmosphere. In another collaboration, physical oceanographers are working in close conjunction with biological oceanographers and specialists in remote sensing in the Global Ecosystem Study (GLOBEC). This is helping to reshape our ideas of the interplay between physical circulation and biological responses in the ocean.

UBC is ideally placed to take full advantage of these exciting, multidisciplinary, multinational programs given our location on the west coast of Canada and our outstanding tradition of open-ocean research. But from the physical perspective we are now unable to seize such initiatives as a direct consequence of two decades of progressive shrinkage of the physical oceanographic group. In particular, we lack a sea-

going physical oceanographer who can collaborate with other members of EOS in providing expertise in open-ocean synoptic and dynamical oceanography.

Acquisition of a sea-going physical oceanographer would benefit EOS in other ways, not least of which would be partial relief of the intense teaching pressure felt by the remaining members of the discipline. Such an individual would strengthen our external ties with the Institute of Ocean Sciences on Vancouver Island, and our internal ties by reinforcing links with our atmospheric scientists as well as other members of EOS who are interested in marine research and large-scale global change issues.

Earth Environmental History and Evolution: Some of the most exciting and challenging questions in the earth sciences fall within the scope of sedimentology and sedimentary geology. Our understanding of the connectivity and feedback mechanisms within modern environments is building into general models; sedimentary rocks permit the testing of these models while at the same time providing information on unique or low frequency events.

We need a person to complement our research strengths in biogenic sediments, coal geology, paleobiology and paleoceanography. The hiring net should be cast wide but we see particular scope for someone studying biosphere-geosphere interactions; the effects of tectonics and eustatic sea level changes on sedimentary environments; and the sedimentary record of climate change. Depending on the interest of the person, there is scope for forging links with the oil industry (where many of our undergraduate students find employment) or with the federal or provincial geological surveys.

The teaching needs are considerable. We must broaden our offering of graduate classes if we are to make UBC attractive as a place for graduate students to study sedimentary processes and the evolution of sedimentary environments. At the undergraduate level, there is scope for teaching in first year and in upper level courses in stratigraphy (especially sequence stratigraphy), sedimentology, and basin analysis. As demonstrated by others (e.g. in Science I) there is considerable potential for interdisciplinary teaching across campus, both in the classroom and in the field.

Biological Oceanographic Processes and Ecosystem Dynamics: Recognition is increasing that global climate change is having significant effects on marine ecosystems, to the point where this broad problem is now a nexus of inquiry that involves phytoplankton and zooplankton biologists, behavioural ecologists, biochemists, fisheries experts, modellers and physical oceanographers. In that it bears directly on the fate of fish stocks worldwide, the issue is severe. UBC is well placed to contribute to this major problem in global change research except in one key area: zooplankton ecology. There is a vast trophic gap between the viruses and phytoplankton that Suttle and Harrison study, and the salmon and other fish that Dower and Healey study. Zooplankton fill this gap. Understanding their behaviour and responses to ecological stimuli such as changes in atmospheric circulation, upwelling, and primary productivity is fundamental in determining how whole marine ecosystems adjust to environmental variability. Such determinations must be made if we are ever to understand what controls the stocks of many commercially important fish species such as salmon.

Given the existing strengths in biological oceanography within EOS, a better understanding of marine ecosystem adaptations will ideally require a researcher in zooplankton ecology who is committed to conducting both field work and ecosystem modeling. Such an individual will play an important role internally by bridging to field research and modelling that is being conducted at both higher and lower trophic levels. Furthermore, he or she will strengthen the initiative established by the recent private-donor funding of the Chair in Ocean Environment and Its Living Resources. Outside EOS, a zooplankton specialist would provide additional links to both Zoology and the Fisheries Center, neither of whom currently have a faculty member in this area. Given that there is only one zooplankton expert on the entire west coast of Canada at present (David Mackas at the Institute of Ocean Sciences), we foresee the establishment of many collaborative ties off campus. These would include links with biological oceanographers at the University of Victoria, Simon Fraser University and the Pacific Biological Station of DFO in Nanaimo, as well as strengthened participation of EOS scientists in the international GLOBEC (Global Ecosystem Study) program. The possibilities for further international collaboration in the North Pacific region with scientists from Japan, Russia, Korea, the U.S. and Taiwan are also very strong.

Finally we note that the appointment of a zooplankton-oriented ecosystem dynamicist would be of great benefit to the teaching of biological oceanography on campus. Teaching strength in this core discipline has been strained by a recent retirement (Lewis) and will become unsustainable upon the pending retirement of Taylor.

◆ **For Future Consideration**

The following list emerged from discussions at the April 2001 EOS retreat. Its purpose is to generate discussion within EOS and to sharpen thinking about future requirements. Suggestions that meet with favour will be developed and transferred to the Hiring Pool; those that do not will be purged and replaced.

Terrestrial Carbon Cycle

Petroleum Geoscience

Neotectonics

Limnology

Estuarine Oceanography

Experimental Solid Earth Physics: Petrology/Geochemistry

Technical and Educational Support

EOS currently has serious problems because of lack of (i) personnel in computer systems management, (ii) laboratory technicians, and (iii) education technologists. A retirement schedule for our technical personnel is given in Appendix 2. As recommended in the Stull *ad hoc* Committee report (2000), we have committed to convert up to two faculty positions into this kind of support. Concrete steps taken since the Stull report was accepted include: (i) reclassification of the position formerly held by Laplante to that of EOS System Manager and hiring of Dan Razzell to fill that role; (ii) reclassification of David Jones' position from Technician III to Technician IV; (iii) normalization of John Amor's position as Computing System Administrator from 50% to 100% EOS supported; (iv) assignment of the full time Lecturer position to an FTE slot; (v) a commitment to hire a Laboratory Manager for the PCGIR laboratory. Our need in education technology is detailed below.

Computer Applications to Education in the Earth Sciences: The potential for using the web, geographic information systems and earth science databases as teaching tools has barely been explored in EOS although we are off to an excellent start. The loss of Michelle Lamberson has underlined the need to retain a full-time person who has an earth science background, who embraces rapidly-evolving computer technology and who is a perceptive teacher. Research faculty members do not have time to fulfill this role, although we all pay lip service to its importance and now realize we cannot flourish as a Department without it. There are, of course, other ways to address this issue (e.g. through non-teaching staff with casual help) but we would argue that the teaching aspect is just as important as the technological aspect and that the task is important enough to warrant a permanent position. This person would help every EOS faculty member, and could teach a 'computer applications in earth sciences' course as well as contribute to teaching in their area of specialization.

Sources

- 1) EOS Retreat reports 1998, 1999, 2000
- 2) Draft Report of the Vision Committee (Pedersen, 1997)
- 3) Report on the Department's Core Strengths (Allen, 1998)
- 4) Reports on Hiring Priorities (Ellis, 1999; Stull, 2000)
- 5) TREK 2000 document
- 6) UBC Academic Plan
- 7) UBC Strategic Research Plan

APPENDIX 1

Undergraduate Enrollment in EOS A Five-Year Plan

Preamble

The units that merged to form EOS had markedly different histories with respect to undergraduate enrollment: 1) Geological Sciences and Geological Engineering had reasonably healthy enrollments; 2) Oceanography did not have undergraduates of their own but supervised a small number of joint honours students; 3) Geophysics had a very small undergraduate enrollment, and 4) Atmospheric Sciences enrollment was small but the unit only developed a unified undergraduate program in 1996 and has been trying to raise its profile in the Faculty of Science since joining EOS in 1999. Collectively our undergraduate enrollment was low at the time EOS was formed and it has not shown marked improvement since.

As is clear from the main body of our Vision and Hiring Plan, we believe that many of the next century's fundamental scientific questions fall within the Earth, Ocean and Atmospheric Sciences. Accordingly, our undergraduate programs must attract the best students and we must provide them with a comprehensive understanding of how the Earth works. In addition to training the next generation of earth scientists, we must also expose undergraduates from other disciplines to the important issues being addressed within the Earth, Ocean and Atmospheric Sciences. This in turn will help raise our profile in society at large.

Problems

- 1) In comparison with many other Faculty of Science Departments, EOS has a disturbingly low FTE to faculty ratio
- 2) Some of our upper level classes fall below the Senate-mandated minimum enrollment of 15
- 3) We now have competition in the Province. In the last decade, the University of Victoria has opened an Earth and Ocean Sciences Department and Simon Fraser has opened an Earth Sciences Department. Furthermore, the number of 2-year colleges and their capacity for offering lower level transferable courses has greatly increased. These developments represent substantial new drains on the potential undergraduate pool.

In spite of UBC's insistence that it is a preeminent research university, resources are routinely allocated on the basis of undergraduate enrollment. As a consequence, EOS is in danger of being the target for financial cuts during retrenchment or of missing out when new funds become available for resources or personnel. Eventually this will undermine our research capacity.

Furthermore, as the Province's premier Solid and Environmental Earth Sciences Department, we have an obligation to provide a full suite of undergraduate classes necessary for registration as professionals. If we lose key specialized classes because of low enrollment, it will simply make EOS less attractive to students thereby exacerbating the problem.

Goals

- 1) Increase our FTE enrollment by at least 50% (to 550).
- 2) Ensure that all our classes meet the 15 minimum enrollment requirement.

Strategy and Schedule

The problems facing us are significant and require long-term solutions. Our approach will be on two fronts: (1) curriculum revision and (2) promotion, advertising and liaison. We anticipate that curriculum revision, which began in 2000/1, will take two years to complete and that another 3 years will be required for the effects to diffuse into all levels of our undergraduate programs.

Curriculum Revisions- Year 1 (effective 2001/2)

New First Year Courses: These courses reflect both the intellectual excitement of our science and its relevance to society.

- The Catastrophic Earth- Natural Disasters
- The Solid Earth- A Dynamic Planet
- The Fluid Earth- Atmosphere and Oceans

Using our best teachers and cutting-edge teaching methods we see these courses as the foundation of our new curriculum and a primary catalyst for growth.

EOS Majors Program: This new, flexible degree program encompasses the broad spectrum of disciplines within the Department. Other than a "fluid" and a "solid" Earth course, there are no requirements for specific EOS courses, except as prerequisites for upper-level courses. Students also have the flexibility to choose a total of 48 credits of electives outside of Earth and Ocean Sciences. Therefore, students are free to largely craft their own programs. For example, students can:

- take courses that provide a solid understanding of how the Earth works as preparation for further degrees in education, medicine, law, journalism, or other disciplines;
- craft a multi-disciplinary program such as environmental pollution, climate change, geomicrobiology, remote sensing, and others;
- focus on a specialization such as geology, geophysics, oceanography or atmospheric sciences. Qualification for registration as a professional is also possible.

Course Rationalization: A committee chaired by Curtis Suttle assessed all the classes that did not consistently achieve the minimum enrollment. The committee formulated lists of courses that should be cancelled, merged, offered in alternate years, or closely monitored in the future.

Curriculum Revisions- Year 2 (effective 2002/3)

The Environmental Sciences Program: At the EOS Retreat held on April 6, 2001, the Department voted unanimously to adopt and administer the Environmental Sciences Program which at present has no fixed location within the Faculty of Science. A committee will be struck to consider the details. It is anticipated that enrollment in this program will eventually increase to 80.

Potential Common Core Courses: A Committee chaired by Greg Dipple will consider the possibility of developing new courses that transcend the old boundaries within and between the Solid and Environmental Earth Sciences, e.g. computer methods in EOS, fluid dynamics, etc. In order to make room for the new courses, existing programs will be modified, some existing courses will be removed and other courses revised.

EOS Honours Program: The Dipple Committee will assess the potential viability of an EOS Honours Program to complement our EOS Majors Program. An Honours program would encourage academically strong students with interdisciplinary interests.

Joint Programs: Joint programs can produce a combination of skills that make students particularly attractive to employers e.g. Computer Science, Law, Commerce. Some of these potential partner programs are seriously over-subscribed and collaboration could help relieve this pressure. The Dipple Committee will consider the scope and feasibility of developing such joint programs.

Summer School: The summer is a time when academics tend to focus on research and this is particularly true of the Earth sciences where field programs and cruises are such an integral part of the work. However, it is apparent that many undergraduate students require summer classes (e.g. in education, coop programs, etc.) and EOS is not meeting these needs. Through our instructors, lecturers and the judicious use of sessionals, we must explore the feasibility of expanding our summer offerings.

Promotion, Advertising and Liaison

Schools: Atmospheric Sciences, Geology, Geophysics and Oceanography are rarely taught in high schools and most students are unlikely to know individuals with careers in these fields. We intend to substantially increase our outreach efforts, contacting high school councilors and making presentations in the high schools. One of the individuals most involved with this will be Stuart Sutherland, a recently hired Lecturer, who has a degree in teaching as well as a Ph.D. in geology. Beginning in the summer of 2000, we will be doing targeted mail-outs to top students in high school and first year (this has been a successful approach for the Atmospheric Sciences Division). In addition, specific classroom resources, lesson plans and access to material within the department will be offered to schools and in particular teachers of grade 12 students. This will serve to promote a greater awareness of the Earth and Ocean Sciences and highlight UBC as a centre of excellence within these disciplines in both a teaching and research context. In this way we can create a pool of enthusiastic and informed students who are already well aware of our programs and potential careers.

Public Relations: EOS now has a reconstituted Public and Internal Relations Committee (PIRC) chaired by Roland Stull. PIRC has been given increased financial and personnel resources in order to meet the new enrollment challenge. We will use the Web, posters and fliers to communicate with the schools and with students already registered at UBC. For example, to inform potential students of possible career paths, we intend to add a section to our Web site dealing with “Careers in Earth and Ocean Sciences”; it will include interviews with successful graduates. We also intend to make existing and potential students feel more welcome in EOS by improving our mentoring and advising activities.

College Liaison: More than 20% of our Solid Earth Sciences students transfer to UBC from 2 year colleges. There is every indication that the number of transfer students in the BC system will increase because the colleges are aggressively expanding their lower level and even upper level course offerings. We must make sure that UBC maintains or increases its share of this pool. We can do this in two ways:

- 1) As with the high schools, we must use PIRC to promote EOS in all British Columbia’s colleges, both to the students and to the advisors.
- 2) Curriculum changes are often difficult for the colleges because they have limited resources with which to respond. If our changes mean that their courses are no longer transferable then an inevitable loss of students will result, particularly if the other BC universities are more accommodating. We must therefore involve the colleges more directly in curriculum changes by consulting with them before rather than after the fact. Furthermore, while still maintaining the integrity our programs, we must do all we can to facilitate transfer by being as flexible as possible in recognizing course equivalents.

APPENDIX 2

Schedule of EOS Retirements and Projected Hiring 2001–2010

SLOT	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ellis	■									
Knight		■								
Taylor (50%)*				■						
Healey (no salary)				■						
Brown					■					
Harrison 50%						■				
Clarke						■				
Clowes							■			
Fletcher								■		
Ingram										■

Table A2-1. Schedule of faculty retirements and departures for EOS

* Not available. Bridged to and committed as a joint appointment with Botany

SLOT	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CRC residuals \$50k	■									
CRC ?			■							
CRC ?					■					

Table A2-2. Current and prospective hiring for EOS.

EMPLOYEE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ramnarine				■						
Rodway								■		
Cranston										■
Polson										■

Table A2-3. Schedule of retirement dates for EOS technical staff.*

* The above table represents retirement dates for EOS technical staff based on current retirement provisions. There are no plans at present to introduce an early retirement incentive package, but it is worth noting that a change to early retirement provisions could accelerate this schedule.

APPENDIX 3

EOS Hiring Plan in the context of UBC Strategic Research Plan

POSITION	CORE Essential to EOS teaching and research	CRC -A Part or potentially part of CRC theme	CRC - B Combination of CORE and CRC theme
Geophysical processes			■
Engineering geology			■
Global process modelling		■	
Microbiology of geological environments		■	
Biological oceanographic processes and ecosystem dynamics		■	
Geodynamic process modelling		■	
Land surface process modelling		■	
Sea-going physical oceanographer			■
Earth environmental history and evolution			■

Table A3-1. Current and planned faculty hiring for EOS

YEAR ONE	Tier I	Tier II	CIHR	NSERC	SSHRC
Biotechnology & genomics	1	0	1	0	0
Human health & genomics	4	1	5	0	0
Neuroscience & cognitive systems	4	0	3	1	0
Population health ...	1	0	0	0	1
Microelectronics & info technology	3	1	0	4	0
Quantum structures & information	0	1	0	1	0
Origins & mathematical structure	1	0	0	1	0
Society & culture	2	1	0	0	3
Sustainability/Environment	4	0	0	3	1
TOTALS	20	4	9	10	5

Table A3-2. Year one CRC hiring plan for UBC (after Oct 2000 Strategic Research Plan)

YEARS ONE AND TWO	CIHR	NSERC	SSHRC
Biotechnology & genomics	3	4	0
Human health & genomics	13	0	0
Neuroscience & cognitive systems	5	2	1
Population health ...	2	0	3
Microelectronics & info technology	0	7	0
Quantum structures & information	0	2	0
Origins & mathematical structure	0	2	0
Society & culture	0	0	7
Sustainability/Environment	0	10	2
TOTALS	23	27	13

Table A3-3. Years one and two CRC hiring plan for UBC (after Oct 2000 Strategic Research Plan)

UBC CLUSTER OVERVIEW

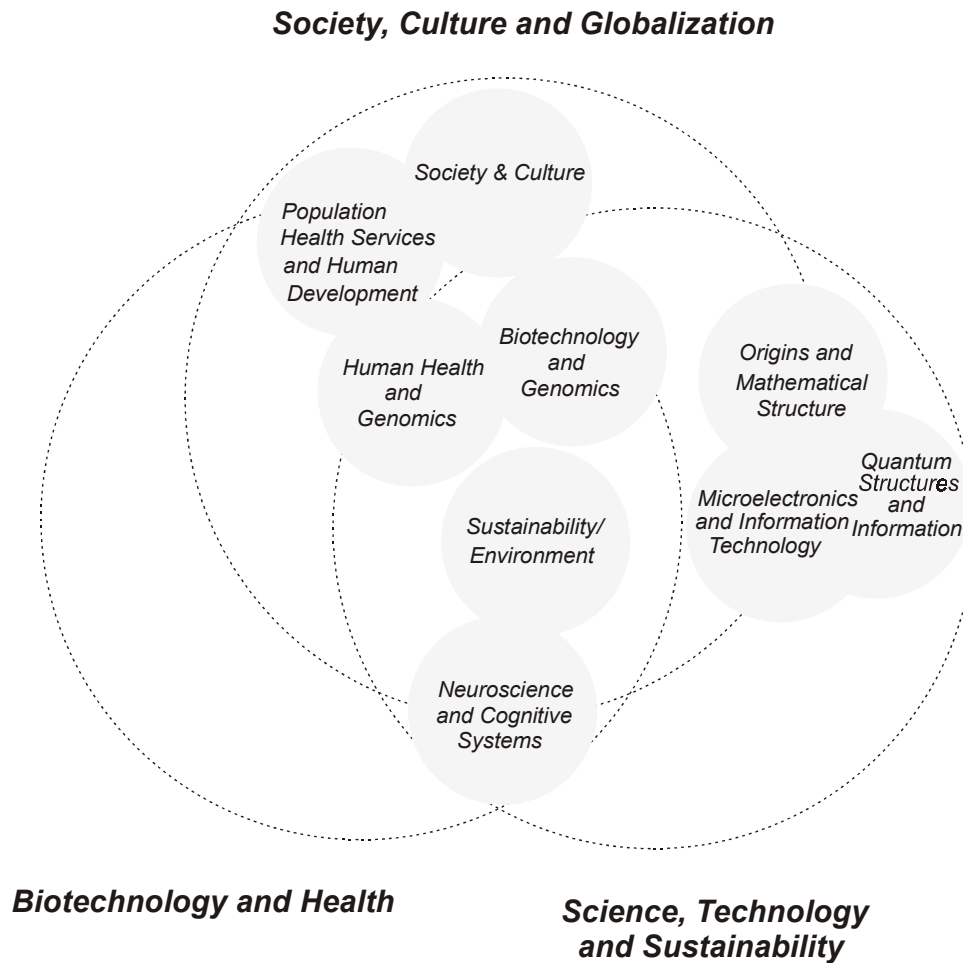


Fig. A3-1. Overview of UBC clusters for CIHR/NSERC/SSHRC CRC chairs (after UBC Strategic Research Plan, October 2000).