Transfer Innovations Project

Flexible Pre-Major Analysis, Earth Sciences

Final Report

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Introduction

The author and members of the BC Colleges and Universities Earth Science Articulation Committee (ESAC) took on the task of investigating the possibility for creation of a flexible pre-major for Geology/Earth Sciences within the British Columbia college system, to facilitate transfer of students from college to university programs. This contract was awarded in 1999 by BCCAT in conjunction with a second contract (to Robbie Dunlop, Simon Fraser University) to establish descriptive pathways for existing programs in Earth Sciences. Discussions between the two contractors and with other members of ESAC led to the realization that the two projects should be to a degree laddered; that is, the descriptive pathways must be outlined before a flexible pre-major can be constructed from the documented and tested transfer pathways. This decision led to an early emphasis upon the transfer grid, but it soon became evident that ongoing program changes at UBC were much more extensive than we had imagined in making the application. Both projects thus proceeded in a somewhat sputtering fashion as we gradually learned of the UBC revisions. UBC is not at fault here; rather, our timing in making the application turned out in retrospect to be the worst possible. Given that rocky start, the present offering is only a small step in what must be a continuing process.

The Flexible Pre-Major

A "flexible pre-major" is defined as

> *the requirements (usually expressed as a set of first and second year courses) necessary for acceptance in to a major program at the third year level* (p. 2, Innovative Transfer Models, BCCAT, March 1999).

The implication is that such a major would be broad enough to encompass the first- and second-year requirements of programs in the three universities that offer Earth Science undergraduate degrees: the University of British Columbia, Simon Fraser University, and the University of Victoria. This would allow ready transfer of students between institutions without undue delays. In terms of the BCCAT Principles and Guidelines for Transfer (BCCAT 2000b), the following principles are particularly relevant:

1. The objective is to facilitate student mobility and thus increase accessibility to programs.
2. Institutions must plan for acceptance of students from other institutions.
3. Nevertheless, the academic integrity of individual institutional programs must be protected and preserved.
4. Transfer credit should be on the basis of equivalency of achievement and knowledge.

Implicit in these considerations is that some degree of comparability and ease of transfer must already exist between institutions at the university level in order that college programs can

be properly aligned. It would be possible for college programs to accommodate a certain degree of variation amongst university programs, but significant differences would complicate matters for college students who wish to keep their choice of senior (target) institution flexible until the end of the second year. This problem was identified by the BCCAT Transfer & Articulation Committee:

> where these requirements differ substantially from one receiving institution to another, it becomes increasingly difficult for sending institutions to offer the range of courses needed for students to have a choice of transfer destination (BCCAT 2000a:2).

Background: Committee and Discipline

ESAC is consistently well attended and has done much in the past few years to overcome problems of transfer. Students from colleges throughout BC travel along a variety of pre-major pathways and are able to transfer into the major programs at UBC, SFU, and UVic. However, these programs are not identical, reflecting differences in composition and philosophy, and (in keeping with the stated principle of institutional integrity) such diversity is viewed as a positive factor, helping to promote the multiple pathways of investigation that strengthen and enrich the Earth Sciences. This diversity also, in itself, constitutes a form of flexibility in allowing students a choice of major programs based upon a match of individual interests, career plans, and program strengths.

Differences do also exist among these programs in the transferability of specific courses and impediments to transfer appear to be a problem area for students. One avenue toward the resolution of any problems, without requiring these programs to resemble one another more closely, would be to focus as strongly as possible upon the learning outcomes associated with the overall programs and the courses within them. However, this suggestion has met with only lukewarm interest on the part of university program representatives, at least in part because it adds a level of bureaucracy to course design and could restrict year-to-year instructor flexibility in course delivery, always a hallmark of dynamic university curricula.

As a "hard science," Geology/Earth Science is an area in which varied program requirements could become a problem area and an impediment to institutional transfer, particularly between pre-major and major programs. The problem is not simply one of institutional "rigidity" involving program details. In the past, curricula were more stable and were designed within what one could call "traditional" views of Geology (for example, as comprising, at first-year level, a term of Physical Geology and a term of Historical Geology). Now, however, the Earth Sciences are undergoing a major paradigm shift with the increase in international awareness of Global Change, coupled with new understandings of the interplay between the oceans, the atmosphere, and the lithosphere. Thus a newly packaged and vibrant "Earth System Science" is emerging from the fusion of elements of several disciplines, applying

the long-term time perspective of geology to the growing understanding of modern earth processes. Programs at UBC and UVic, for example, have grown from the administrative fusions of formerly separate departments and programs in earth, ocean, and atmospheric sciences, with considerable revamping of course and program offerings. In this environment it seems that the colleges will be forced to run faster and faster just to stay in the same place, given that they must follow the lead of the universities, all of which are acting independently in terms of program design. If the recent past is any indication, there will be many more program changes and course additions/revisions to come.

Program flexibility is clearly needed and desired, but must reflect more than simply ease of transfer among institutions because it is to a certain degree constrained from outside. University and therefore college university transfer programs are also driven to an extent by set syllabus requirements of provincial accreditation bodies -- for Geology, the Association of Professional Engineers & Geoscientists of BC (APEGBC). Given this professional environment, a department with a major in Earth Sciences/Geology must provide enough courses not only to satisfy its own BSc requirements but must also provide students with a reasonable opportunity to meet APEGBC syllabus requirements, without which they cannot legally sign professional reports or act as consultants. On the other hand, no department can simply adopt such a syllabus, with its various streams, as the sole blueprint for a program because not all majors are going in the direction of professional accreditation. The program streams set by APEGBC are more "traditional" than those of the universities and focus strongly upon careers in resource extraction, engineering geology, and environmental geoscience. Earth System Science, but extending beyond traditional geology courses, also strays beyond the APEGBC syllabus and students are forced in some cases to take additional courses for certification than they need for the BSc.

Process

Inasmuch as the first objective (documentation of existing pathways) was shared with the contract for Transfer Innovations: Descriptive Pathways (to ESAC, through Robbie Dunlop, SFU), some of the activities involved in analysis of the pre-major were shared with that project. Joint ad hoc committee meetings were held in Parksville, Calgary, and at BCCAT offices in Vancouver. In addition, the present author and ESAC liaison officer Des Wilson (Douglas College) travelled to UBC (Vancouver), SFU (Burnaby), and UVic (Victoria) to meet with department chairs and undergraduate program advisors. Given that the details of program equivalency are to be provided in the Transfer Grid prepared by Robbie Dunlop, the emphasis in the present report is upon areas of specific interest (or disagreement) between programs.

At the time the application was made to BCCAT, ESAC was incompletely aware of the scale of planned program changes at UBC. From the time of the award in 1999 until the summer of 2002, these changes were under way and had immediate impact upon production of a final report. Some intended comparisons could not be made until this past year because of

uncertainties as to program structure; for example, in some cases we knew of planned changes but they were going through the process of administrative approval at UBC and no assumption could be made that approval would be automatic. The bulk of the changes at UBC were generated from within as part of a major program redesign and changes were communicated to ESAC as they were being implemented. Colleges were not consulted ahead of time as to the impact of these changes, which is understandable given the complexity of the task even within UBC. However, the process did put colleges and ESAC in the position of waiting for the outcome, and any redesign of college programs can only now be made.

Documentation of Existing Pathways and Transfer Patterns

Program details are to be provided in the Transfer Grid being developed by Robbie Dunlop. All three major universities provide pathways toward APEGBC registration but warn students that such paths may involve the taking of additional courses beyond the requirement for the BSc. The discussion that follows is limited to the extent that it focuses upon the geology stream. Each university now has multiple streams involving Geology, Environmental Science, Geology/Geophysics, a variety of joint majors, and so on. The complexities almost defy comparison at this point, but more importantly, the "mainstream" of geology is coming to be different from institution to institution. The differences reported here provide and indication of the extent of differences that also exist in other streams.

There is now a difference in first-year geology requirements between UBC and SFU. "Traditional" geology programs tended to include in the first year a course in Physical Geology followed by Historical Geology, as is still the case at SFU (EASC 101 and 102). UBC, however, now provides a couplet of Solid Earth (EOSC 110) and Fluid Earth (EOSC 112, Oceans and Atmosphere), of which only one is needed for first year and the choice depends upon the program. In the case of the geology stream, the choice would be the Solid Earth course. The implication of this is students who take college programs with Physical and Historical Geology in first years are in step with SFU but slightly out of step with UBC. First-year requirements at UVic include a Dynamic Earth/Global Change course (EOSC 110), followed by a Physical Geology (EOSC 120), so again the Historical Geology course is supplanted; however, there is overlap between Historical Geology and the material of the first course.

This variety has positive and negative implications for college programs. UBC offers an additional first-year course (Environmental Disasters) which also leads on to another of the EOSC streams, so from a positive standpoint a college could offer as many as five first-year Geology courses: Physical Geology, Global Change and/or Historical Geology, Natural Disasters, and Oceans and Atmosphere. The student, however, would be forced to choose at the very outset the desired target university, counter to one of the goals of the flexible pre-major. Discussions with UBC and UVic department representatives indicate that there is flexibility in acceptance of a first-year transfer courses, but this would be applied on a student-by-student

basis for the time being.

The UBC program includes at second-year level a course in Geological Time (EOSC 222), and at present the introductory Historical Geology course is taken as its equivalent. Such would be an easy resolution of the first year problem were it not for the fact that the UBC course is (despite its more general description) dominated by paleontology and is accepted by APEGBC as the Paleontology course credit. Other programs, such as SFU, have a second-year course devoted to paleontology *in addition to* the first-year Historical Geology. Thus a student transferring from SFU to UBC would only receive one course credit (Earth Time) for the two courses taken, and would also face the anomaly with the APEGBC (how could Historical Geology transfer to a UBC course which gets the APEGBC Paleontology credit; yet the SFU course is not itself the Paleontology credit because there is an appropriate second-year course?). In turn, the problem is extended to the colleges, as at Douglas, where Historical Geology and Paleontology are both offered, in step with the SFU program. This issue needs to be resolved, and it would seem inappropriate that a first-year course in Historical Geology transfer to UBC as equivalent to the Earth Time course. A possible solution discussed with UBC representatives was that Historical Geology could be accepted at UBC, in effect, as "EOSC 1XX," acceptable in lieu of the required Solid Earth course; but that would still mean that only one first-year course credit would be needed at UBC. It seems inescapable that some students in the colleges will end up with excess course credits if they delay in making a choice between UBC and SFU/UVic.

Of earth science courses in second year, only one is shared across the three major programs. That course is Mineralogy, which therefore stands as a potential offering at colleges (and has been offered at Douglas College). However, the additional flexibility of college programs in terms of the timing of courses allows many students to delay taking Math, Chemistry, and Physics courses and from an FTE standpoint it has been difficult to find enough students with appropriate prerequisites. Courses taught at two institutions include Paleontology (if we take the UBC Earth Time course to be a Paleontology course), Stratigraphy/Sedimentology, Structural Geology, Petrology, Geochemistry, and Field School. All are potential offerings at college level, with the caveat that they do not necessarily provide transfer. To date it appears that courses taken at second-year level in a college are not accepted as third-year (upper level) credits in a university.

Table 1. Comparison of First- and Second-Year Geology Major Programs (note: course titles here are *not* the official titles but are shorthand descriptions derived from the outlines)

	UBC	***UVic***	***SFU***

Yr 1	ENGL 100-level (112 is recommended)		
	CHEM 121,123 (111,113)	CHEM 101, 102	CHEM 121-4 General Chemistry I; CHEM 122-2 General Chemistry II; CHEM 126-2 (Lab)
	CPSC 100-level		
	EOSC 110 Solid Earth	**EOS 110 Intro. to Earth Sci. I (Global Change) EOS 120 Intro to Earth Sci II (Physical Geology)**	**EASC 101-3 Physical Geology EASC 102-3 Historical Geology**
	MATH 100 or 102 or 104(or 120 or 180 or 184)	MATH 100	MATH 151-3 Calculus I
	MATH 101 or 103 or 105 (or 121)	MATH 101	MATH 152-3 Calculus II
	PHYS 107, 108, 109 (101, 102)	PHYS 112	PHYS 120-3 General Physics I PHYS 121-3 General Physics II PHYS 131-2 (Lab)
			STAT 101-3 Intro to Statistics
Yr 2		**EOS 201 Sedimentary Geology**	**EASC 201 Stratigraphy & Sedimentation**
	EOSC 220 Intro Mineralogy	**EOS 205 Mineral Sciences**	**EASC 202 Intro Mineralogy**
	EOSC 221 Intro Petrology		**EASC 205 Intro Petrology**
	EOSC 222 Geological Time		**EASC 203 Paleontology**
		EOS 202 Structural Geology	**EASC 204 Structural Geology I**

	EOSC 223 **Field Techniques** **(+May Field Schl.)**		**EASC 206** **Field Geology I**
			EASC 207 **Intro to Geophysics**
		EOS 240 Geochemistry	**EASC 208** **Geochemistry I**
	CHEM 202, 205	CHEM 222, 245	
	Science Elective	PHYS 210	**GEOG 213** **Geomorphology**
	Arts Electives	MATH 200 (or 205), 201	
		Elective	

Can we create an idealized "model program" against which existing college programs can be compared and evaluated?

On the basis of the foregoing, there are two courses that are still accepted "across the board" and which should remain as core offerings in the colleges: Physical Geology, Historical Geology (which may require revision in terms of UBC transfer). At second-year level, Mineralogy is required by all three but prerequisites may complicate its implementation in college programs, as might also be the case with Structural Geology, Geochemistry and Geophysics. A good variety of second-year courses is available, but no single package is applicable to all three institutions. It appears, therefore, that there cannot be a "flexible pre-major" in the sense that a student would be able to complete such a program and *then* decide which institutional transfer to make. The information assembled thus far suggests a degree of flexibility in acceptance of first-year courses, but the institutions diverge too much at second year for a student to be so late in making a decision. Differences exist not only in the selection of Earth Science courses, but also in the selection of supporting courses (Computing Science, Statistics, Chemistry, Geography (Geomorphology).

Thus it seems evident that a college student must choose during the first year whether to target UBC, SFU, or UVic. Our site visits left us with the strong feeling that all three programs are well organized, exciting, and attuned to career needs, so that may not be as great an imposition upon the student as it may first appear.

An Additional Fly in the Ointment

Discussions at regular ESAC meeting and during the course of this study revealed another discrepancy between university programs that is problematical for students and affects their decision-making in taking courses at colleges. The Introductory Physical Geology course is in some cases quite similar to an Introductory Physical Geography course. Geology and Geography tend to be in different university faculties but the two courses do overlap, with geographers being strongly interested in earth surface processes. Differences exist in the degree to which rocks and minerals are studied (more intensively in Physical Geology), the emphasis upon mapping skills (more in Geography), study of the atmosphere (included in Physical Geography), and detailed consideration of the inner earth (more intensive in Geology).

The problem is that some institutions or programs consider the two courses to be the same; while others do not. Unless the situation has recently changed, both the Geography and Earth Science departments at SFU accepted *either* course as a way into their programs. Thus a college student with one could not take the other for credit, because they would be considered the same course for transfer purposes. At UBC, however, Physical Geography was taken to be to conduit to the Geography program, while Physical Geology was taken to be that for the Geology program, so both courses could be taken for credit by a college student intent on transfer.

Here, then, is another case of different transfer criteria between universities; and in this instance it affects the very viability of a *first-year* offering in Earth Science. If a student can take either course (Geography or Geology) to get into a Geology program at a university, then the Geology program at a college cannot count even upon healthy enrolment in its first-year offering, for the students may be split between two departments. This offers the unhealthy possibility of interdepartmental rivalry, to the extent that even a suggestion to resolve the issue could cause animosity, in light of the overwhelming emphasis of FTE numbers in the funding of college programs.

The above information is offered with the additional comment that talks have already begun: the Earth Science and Geography Articulation Committees held joint meetings in Prince Rupert in 2002. In doing so, they were undertaking the next step in an issue defined by ESAC in the course of the present project.

Alternative Measures of Equivalency

ESAC members are aware of the desire at the Ministry level that transfer relationships be as flexible as possible in order that students moving between institutions do not experience

delays in program achievement; yet there is also a need for a set of specific skills and a fund of basic knowledge that can be defined as geological in nature. Thus prerequisites must be specified, but in the BCCAT view to maximize flexibility we would be advised to describe and design them in terms of explicitly stated learning outcomes. It might indeed be possible to design transfer programs that are conceived not so much as sets of courses but as sets of outcomes which are attainable through a variety of pathways.

However alluring this may sound in theory, it seems far off in practice. The ESAC group discussing the Flexible Pre-major did meet in Parksville to compare outcomes at the first-year course level. Further discussions raised the problem of the Historical Geology transfer, which led in turn to discussions with the universities. Our suggestions that learning outcomes could be used as a basis for transfer were met with only lukewarm interest and it appears that nothing of this sort will be undertaken for some time to come. Given the changes ongoing in Earth System Science, the fear is that such outcomes (even involving what seem to be “basic skills”) will have to be rewritten constantly, introducing little more than a new level of bureaucracy to the system.

Recommendations for Improvement of Program Integration among Institutions

The single most important factor remains direct communication among the institutions involved, and I am confident that ESAC members will continue to benefit greatly from our annual meetings. Communication about transfer problems and the structure of curricula is the prime concern at these meetings and much is accomplished on a problem-by-problem basis. ESAC also facilitates institutional transfer and parallelism of programs by combining the annual articulation meeting with a field trip to selected geological sites, which further helps us to standardize our offerings by collecting teaching specimens from the same sites and cross-linking our laboratory exercises. This appears to be as close as we will come to learning outcomes for the foreseeable future.

Looking back over three decades of cyclic supply and demand for jobs in the Earth Sciences area, we can see that program rigidity has tended to increase in times when students are in high supply, responding to what is perceived as a favourable job market. High student numbers lead to improved funding levels but also allow programs to be more selective in admissions and to focus on "preferred" pathways. Flexibility in program offerings has, on the other hand, tended to emerge in times when student numbers were waning in the face of perceptions of a weak job market. Program viability can be threatened by low student numbers; hence the interest in attracting more students through flexibility of admission and transfer. The foregoing is not a cynical assessment but states the reality imposed by the strong cyclicity of the resource industries and even the environmental impact industries. Given the present attacks upon earth science jobs by both public and private sector employers, the outlook at present for our students is not rosy. The university programs are now building in *internal* flexibility, which is featured highly in their website descriptions. Such flexibility should, in time, resolve the

outstanding transfer issues through the normal course of ESAC activities. The only warning that needs to be registered in this context is that the next cyclical "upswing" of employment will, as before, bring a rapid rise in student numbers and will consequently tax facilities to the limit. The result will predictably be efforts by the institutions to cut back on flexibility.

Emerging from this study and from discussions in the ad hoc committee meetings have been a number of highlighted problems, and steps are already under way to deal with them. These have already been outlined above:

1. It was realized that ESAC and the colleges were not receiving key information about program changes from the universities until well after changes were first conceived. Thus the colleges were trapped into a reactive mode that meant compensatory changes long after those at the universities. Discussions with UBC department representatives in particular showed that there was a genuine willingness of the university to involve college or ESAC representatives in early discussions of proposed changes. Mark Smith, current ESAC chair, has therefore been able to meet with UBC committees and to get a better idea of the ongoing changes. This, then, was a simple structural matter, difficult to anticipate until the magnitude of changes was realized, but relatively easy to resolve.
2. The definition of Earth Science/Geology/Earth System Science as employed by the universities and colleges is to a certain degree different from that employed by APEGBC. The latter agency is industry-oriented and therefore sees employment as industry-driven; its streams are not particularly sensitive to public-sector, policy-related roles or to academic roles. Thus its syllabus represents a significant departure from the increasing flexibility of university programs. This matter seems to be under review and I am confident that a rapprochement between APEGBC and academia can be achieved. For the moment, however, it remains that APEGBC's idea of an adequate BSc curriculum is different enough from that of the universities that accreditation is not guaranteed by the degree. The relevance of this problem in terms of the two-year pre-major is that it affects the offering of courses insofar as they are (at second-year level) part of the APEGBC approved curriculum. The issue of Paleontology credit and Historical Geology transfer, as outlined above, must be resolved.
3. An anomaly concerning Geology and Geography first-year offerings has been identified and is of considerable concern given college funding based upon student numbers. Discussions between the two Articulation committees began at the Prince Rupert meeting and will continue toward resolution of this issue, under the able guidance of Mark Smith.
4. For the present, at least, a Learning Outcomes approach as a basis for transfer between programs appears to be a non-starter with the universities. The approach does help to evaluate the comparability of individual courses, but appears to be too complex to use at a program level.

An Alternative Transfer Option?

ESAC has affirmed its commitment to enhancement of block transfer arrangements and overall transferability of program offerings. We endorse the ongoing changes at the universities as an inevitable (and entrepreneurial) process in the march of an exciting area of science. We also earnestly hope that moves to ensure transferability do not, in themselves, impair the flexibility of program development at any institution. This is a surprisingly daunting task.

The emergence of Associate Degree programs at colleges provides a possible alternative to the flexible pre-major, should the latter be unattainable. Associate degrees have not only the effect of providing an interim credential, but also underline the dual themes of attainment and challenge. Associate degrees could be adopted by the colleges and used as vehicles for block transfer to university programs. Although block transfer is often awarded on a case-by-case, program-by-program basis, it may be possible to involve several colleges in a single, unified block transfer agreement to one or more universities. From the student's standpoint, this would at least provide some assurance of transferability, though it might well limit program flexibility.

In Closing, a Concern

Earth System Science recognizes the rapid growth and vibrancy of research and applied science in interdisciplinary Earth Science, exactly the area underplayed by APEGBC in its careers documentation. Students are not visionaries; nor are they assisted by existing products. Students tend to get interested in disciplines when they see that many jobs are available. However, in a job market driven by cyclic factors (from resource price cyclicity to changes in government), a decision made in terms of today's job market may not be a wise one at the time of graduation. The alternative is also true: perhaps the best time to start in an Earth Science program is at the bottom of an economic cycle, for things may be much better by the time of graduation. But few have the courage to make such a decision. If government funding sources are based upon student numbers, it is therefore impossible for the ministry, either, to be visionary in terms of program development.

References

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2000b Principles and Guidelines for Transfer. Website posting updated as of 2000. www.bccat.bc.ca/artic/princip.htm .