The Final Report of the

Ad Hoc Science Curriculum Review Committee

of the Eckerd College Natural Sciences Collegium

October 2nd, 2007

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The on-line version of this report has active references which will give the reader direct access to our documents, surveys, and photographs. It is located at: http://academics.eckerd.edu/instructor/weppnesp/SCR/Final.pdf

Executive Summary

This document represents the final report of Eckerd College's *Ad Hoc Science Curriculum Review Committee*, which was created by the Dean of Faculty in October 2006. The committee members, after attending conferences, surveying our peers at other institutions, analyzing our own and other facilities, and talking to colleagues, architects, and administrators, have developed Vision and Mission statements as guideposts for the Natural Sciences Collegium, which have been passed by the Natural Sciences faculty. They have also formulated curriculum and building concepts.

The Vision, Mission, and connected curriculum ideas call upon the science faculty to

1. **Strengthen** the science disciplines. Improve retention in science disciplines by reducing our introductory class sizes, to create better faculty-student interaction, and by exploring the use of more experiential, applied techniques in the classroom.

2. **Integrate** among science disciplines. Progressively provide more learning opportunities, courses, and majors which emphasize an interdisciplinary approach to science.

3. **Bridge** from the Natural Sciences Collegium to the other collegia. Create majors that take advantage of our great strength attracting students to Marine Science and Biology and parlay this into distinctive programs that involve multiple collegia, in areas such as coastal management, science education, and science communication.

4. **Empower** the science faculty to help Eckerd College develop both the best possible science facilities and the use of our landscape by appointing a shepherd who will be our representative to the administration and campus managers in matters related to the physical plant.

By fashioning this document we believe our committee and ultimately the science faculty will begin a long-term commitment to the declarations within. Success will require the support and cooperation of the entire Eckerd community. We hope Eckerd College's administration formally recognizes the importance of, and our commitment to, these ideas.

Introduction

In *Rising Above the Gathering Storm* [1], a report on a study by the *National Academy of Sciences*, the main finding is a serious concern that "the scientific and technological building blocks critical to our economic leadership are eroding at a time when many other nations are gathering strength." For the United States to remain strong in a global economy, it must retain a competitive advantage with regard to innovation in science and technology. This will require a workforce of sufficient size in scientific and technical fields, one that is well-educated and one that is also very creative. There is recognition at the national level for the need to address deficiencies in science, technology, engineering, and mathematics (STEM) with respect to the overall quality of education, especially K-12, but also at the undergraduate and graduate levels. Simply put, we need to increase both the quality and number of people graduating in STEM areas.

Given the strength of the sciences at Eckerd College, we are in a position to make a positive contribution to the nation's efforts to increase the number and quality of students graduating in STEM fields. Indeed, the planning and construction of a new science facility provides the impetus needed to re-envision the sciences at Eckerd College both to address the nationwide concerns described above and to increase the dynamic interaction the sciences have with the rest of the campus. With this realization, Dean Chapin created the Eckerd College Science Curriculum Review Committee with the following charge:

> *To review the College's science curriculum in light of the latest developments in science education and in view of the anticipated construction of the science complex as described in the Program for the Science Complex, prepared by Paulien & Associates, for the purpose of identifying ways in which both the curriculum and the new complex should be designed in order to provide future generations of Eckerd students the best possible education in the sciences within the context of a liberal arts education.*

Given this charge, the Science Curriculum Review Committee has begun to define the educational objectives, pedagogy, course offerings, staffing, equipment, and space needs required to deliver outstanding programs in the Natural Sciences (NAS) Collegium. We believe that by carrying out the *Mission of the Natural Sciences at Eckerd College*, we will advance toward our goal of becoming a leading liberal arts institution with regard to educating undergraduate students in science. The Science Curriculum Review Committee has spent the last year collecting and reviewing information, conducting surveys, and attending conferences. In the next section we detail the committee's deliberations and then present our proposal, which includes the NAS vision and mission statements, curriculum ideas, and a statement about science facilities.

The Committee's Structure and Procedure

In 2003 President Donald Eastman initiated a strategic planning process for Eckerd College[2]. During the 2003-2004 academic year a college master plan was developed, and included a new science complex which would house the Biology and Chemistry Disciplines and be located near the main entrance to campus. Eckerd College hired Paulien and Associates in 2005 to do a space and budgetary analysis of what would be needed to construct this complex. To coincide with this facility assessment, it became apparent to the Dean of Faculty, Lloyd Chapin, and the Natural Sciences Collegium Chair, David Grove, that along with building planning and development a curriculum review of the natural sciences was also needed. The review would be broad, looking across the sciences, with a goal of articulating the Natural Sciences Collegium vision, increasing interdisciplinary collaboration, and asking critical questions to define the science experience for all students at Eckerd College.

The *Ad Hoc Science Curriculum Review Committee* was formed under the auspices of the Dean of Faculty, Lloyd Chapin, in the fall of 2006. Committee members were chosen by him with consultation from David Grove, following a disciplinary representation. The members were Denise Flaherty (Biology), Elizabeth Forys (Environmental Studies), Ed Gallizzi (Computer Science), David Grove (Chemistry), Jerry Junevicus (Mathematics), Peter Meylan (Miology), Steve Weppner (Physics, Chair), and Laura Wetzel (Marine Science). Dean Chapin gave the committee a charge, freedom of exploration, and a generous budget which was used to attend conferences and build a survey. Our meetings began in November of 2006 and continued through September of 2007. Armed with the charge, committee members read relevant literature, explored other institution's websites, prepared and executed a survey of scientists at liberal arts colleges, and had conversations with the Dean of Faculty, the Dean of Admissions, a representative of the *Ad Hoc General Education Committee*, and the NAS faculty. A representative group of the committee attended two conferences, visited New College of Florida, and had discussions with an esteemed architect. The committee also compiled internal historical data, including a list of theses, research projects, photographs, and anecdotes, to facilitate a better knowledge of the Natural Sciences for the Advancement and Admissions offices. These projects and interactions were a catalyst for the open dialog that transpired at our meetings, where we discussed common values, hopes, and concerns of the Natural Sciences Collegium. What follows in this section is a summary of our exploration.

Literature

A natural resource for this committee was *Project Kaleidoscope* (PKAL)[3], an organization which is "Transforming undergraduate science, technology, engineering and mathematics education." PKAL's mission is to "prepare [science] leaders to take responsibility, over the long term, for building and sustaining a strong undergraduate science, technology, engineering, and mathematics learning environment on their home campus." PKAL provides literature, programs, and conferences to achieve this goal. Its efforts have been funded by the National Science Foundation, the W. M. Keck Foundation, the Department of Education, and Exxon Mobile. PKAL, therefore, seemed like a good place to look for relevant literature which would let the committee begin exploring progressive ideas. In subsequent sections we discuss our attendance at two PKAL conferences.

We started our literature review with *Linking the Departmental and Institutional Mission: The Morehouse Experience*[4], a document found on the PKAL website. To lead its students into the future, the Morehouse Biology Department decided that it would need to explore departmental values by developing a mission statement to define the goals of the sciences within an institutional context. Morehouse also recognized that this document would only have significance if it was continually evaluated and amended as needed. They state that their mission statement has deepened their sense of community and has made their goals visible to the institution. Our committee decided therefore that the cornerstone of our report would be a similar

document in which we describe our vision and mission. As we continue to review and improve our curriculum, a mission statement will be a constant reminder of our shared values and goals.

We also looked at *Science Across the Campus: The Binghamton University Story*[5], another PKAL document. It discussed the prospect of developing and teaching more interdisciplinary and team-taught courses under the auspices of an NSF grant. There has been a significant push from granting agencies in recent years to fund more interdisciplinary majors, courses, and projects. At Eckerd College we already have two widely popular interdisciplinary majors, marine science and environmental studies, and we are actively looking for ways to increase interdisciplinary study. This type of development is particularly germane as there is no better way to illuminate and explore the common values and methods of science than by a literal cross pollination between the traditional branches of science in a classroom situation. As reflected in the Binghamton article, both faculty and students reap the benefits of these interactions. The committee understood that for us to succeed as an institution we will continually need to re-examine the strength of our interdisciplinary components. Similarly, we also looked at an internal document by scientists at Skidmore College, *The Future of Science Education at Skidmore College*[6], where students actively pursued interdisciplinary majors such as biochemistry and neuroscience, and where the science faculty viewed interdisciplinary study as a significant emerging feature at leading liberal arts colleges. We found this trend to be true through our own curricular research of other institutions.

In the *Journal of College Science Teaching*, an article entitled *A New Paradigm in Integrated Math and Science Courses*[7] described the evolution of non-science-major courses at Drury University. After rewriting their university mission, working towards a new science facility, and attending a number of PKAL workshops, the science faculty formed a universal science and mathematics general education program. With support from their administration and the National Science Foundation, the faculty created three inquiry model courses which involved a significant amount of experimentation and individual research for the non-scientist. Our committee members also envision, in the ideal, courses for non-scientists which teach the creativity of the scientific method directly through experimental inquiry. We have struggled with finding adequate lab space and faculty resources to better develop the scientific literacy of non-science majors. Our committee, the *General Education Review Committee*[8] at Eckerd College, and national funding organizations such as the National Science Foundation and the Howard Hughes Medical Institute recognize the importance of expanding science literacy to a broader audience. Eckerd College's science curricular requirement needs improvement, but it does not seem reasonable to attempt a program that is ambitious in scope with the facilities and teaching resources now available. Yet the Drury University article deepened our commitment and expanded our ambitions to what is possible in both the short and long terms.

The last formal article we discussed was *Science at Liberal Arts Institutions, a Better Education?* by Thomas Cech.[9] Among the advantages of teaching science in a liberal arts setting, Cech suggests greater nurturing and serious cross-training with the humanities and the arts. Being candid, he also mentions the disadvantages of lack of funds for equipment and research, and the students' lack of exposure to the 'cutting edge of research'. This article prompted committee members to ask the following questions: How do we best achieve the right mix of scientific and non-scientific study for our students? How do we reserve time for first-rate research? How do we compensate for our small equipment budget compared to many research institutions and even liberal arts schools with a much larger endowment than our own? Cech reminded us that although funding and equipment are important, there are some less expensive intangibles that the Eckerd science faculty and the entire Eckerd campus use effectively in educating our students. This thought process is also celebrated in Loren Pope's *Colleges that Change Lives*.[10] We nurture our best students and have a sense of pride when they are celebrated across the entire campus, not only for their accomplishments in science, but also as good liberal arts students and campus citizens.

Research

During the fall of 2006 we also began studying institutions similar to Eckerd College. Each member of the committee chose four or five small liberal arts schools and compiled information from their websites. On a spreadsheet[11] we recorded quantitative data: school size, majors offered, how many faculty members, visitors, and adjuncts per major, how many students per major, etc. Each committee member made notes of interesting facets of the science disciplines within that institution. We then spent a meeting sharing the highlights of the programs we found, especially those highlights which went beyond numbers: interdisciplinary classes, alternative majors, progressive general education, faculty rewards, research opportunities used for teaching, accreditation networks with other schools, and student involvement in informal seminars and colloquia.

From this discussion came a decision to follow up our quantitative analysis with a formal external survey[12] focusing on resources (to see the survey go here). The survey was developed over the January Term of 2007. With approval of Institutional Research and the Dean of Faculty, the survey was distributed in the spring and received spectacular response. We had a return rate of over 28% and heard from 315 individual science faculty members at 63 different small liberal arts colleges. The institutions were spread over the endowment range and *U.S. News and World Report*[13] Liberal Arts Colleges rankings. We also chose all institutions that appeared in Loren Pope's book, *Colleges that Changed Lives*[10] and all institutions that the Dean of Faculty perceives as similar in scope and mission to Eckerd College.[14] The complete results are shown online. In summary we tried to use this survey as a guide for our priorities. The survey helped the committee determine what projects fall within the scope of short or long term goals. For example, it was observed that only schools with large endowments can afford a light teaching load. However, endowment had a smaller effect on the overall class size, and reducing class size was often a healthy step taken by colleges trying to improve the overall interactions between faculty and students. It also showed us that our problems are not unusual and in many ways we seem to be doing relatively well given our size, young age, and endowment. For example, the summer research program, which began in earnest in the early 1990's with a Howard Hughes Medical Institute grant and has been continued and strengthened by the administration in the intervening years, is an extremely strong internal granting mechanism compared to that at other colleges. Overall, as a result of conducting this survey, we now have a better sense of the larger community of dedicated scientists who proudly work at small liberal arts colleges but share a common struggle to find resources and a voice within their larger academic community. The results of the survey, which were distributed to all participants, have appeared on internet list-serves and have been warmly received by administrators and faculty members alike.

Internally we also have begun a better systematic organization of our past work for historical purposes and to help the Admissions and Advancement offices celebrate the sciences. We have begun a listing of all past senior thesis[15] and summer research projects supported internally[16] (there are also many externally funded research projects which we are still in the process of collecting), as well as a repository for pictures and anecdotes[17] about the sciences at this college (to see this collection go here). Science at Eckerd has a very colorful history. Since Eckerd's beginning, it has had a strong science faculty that has received grants and mentored students to successful scholarships, graduate school, and careers. This acknowledgment of our past will be a valuable resource as the Natural Sciences continues to consider its future. We will use these newly accumulated resources to create a Natural Sciences web page; conversations have begun with Eckerd College web designers. We anticipate that this website will be a vibrant reflection of this institution's unique spirit, past and present, as it grows on the Florida gulf coast.

Conferences

Representatives from the committee attended two Project Kaleidoscope (PKAL)[3] conferences. The first,

in March of 2007, was entitled *Planning Facilities in the Sciences and Mathematics*[18] and was attended by Flaherty, Gallizzi, Grove, and architect Charlie Canerday who has an ongoing relationship with the college. Overall, the participants thought the conference was excellent. The conference theme was *What Works?* when designing a science facility. The conference reinforced the lesson of first defining a vision and mission, and the experts agreed that these are valuable first steps before serious planning can be done. We learned that it is also important to review the curriculum, emphasizing shared and common spaces for pedagogy and research, creating space where intellectual collisions take place. The motivation for a new building must also be clearly defined. Administrators and faculty should be able to answer "*Eckerd is planning a new science center because..."* and "*this is important to the college because..."*. The strengths of the college must be emphasized and it should be clear that the new space is first and foremost for students.

At this PKAL conference our committee's members learned that what works in building development and planning is a shepherd acting as the leader, facilitator, and driver behind the process[19]. This person works in tandem with other important members of the building team including fund-raisers, administrators, campus managers, architects, science and non-science faculty, as well as students. This process is delicate, and by examining success stories from elsewhere we consistently found that some variation of this model was followed at the planning stages. The conference frequently reinforced the idea that the quality of space is important and that a science building must be aesthetically pleasing and not just serve the purpose of creating laboratory space[20]. Our architect, Charlie Canerday, called this *the celebrated front door effect*. When the building is entered the sciences should be celebrated in an atrium, lobby, or other open space, and their relation to the other liberal arts accentuated so that the space exudes a presence as a place inviting to all on campus. The conference emphasized that science buildings should consistently pour out a "science on display" feeling, in order to invite students into science learning and provide the fringe benefit of an excellent marketing tool for the college as a whole.

The second PKAL conference that a group from Eckerd attended, in June of 2007, was focused on science curriculum.[21] The participants were Flaherty, Grove, and Wetzel as well as Katherine Watson and Iris Yetter. All thought that the conference could have been better planned and organized, but they returned with valuable assessment ideas (information on the Survey of Undergraduate Research Experiences, for example), and better motivation for interdisciplinary coursework, active learning pedagogies, making the introductory *gateway* courses as effective as possible, educating non-science majors, and generally increasing science literacy across the college campus. This second conference also allowed our faculty members a retreat to discuss with each other, as well as the Associate Dean of Faculty Development, plans for future classes and workshops.

Conversations

Another important source of creativity and reflection was colleagues on campus, particularly our science colleagues. Since its inception, this committee hoped to make its proceedings as open and inclusive as possible. We have stored all documents pertaining to this committee in a central repository (the Eckerd Academic Wiki[22]) to which all Natural Sciences faculty members have access. We sent out four status reports reminding colleagues of document location and seeking advice. We have all shared informal dialog with our colleagues at discipline meetings and over coffee, and in April of 2007 we convened the Natural Sciences Faculty Forum. In this ninety minute meeting, we presented drafts of vision and mission statements, then solicited input. We also discussed the design and placement of the science building and ideas that the faculty had relating to curriculum. What the committee found impressive about this process was that the dialog in the faculty forum was excited, passionate, rich with ideas, and congenial. When science faculty were given the opportunity to brainstorm and imagine this institution's potential, they took that charge seriously and were very helpful in prioritizing our agenda. The committee met with the Natural Sciences Collegium again in September of 2007, presenting a status report. AT this same meeting the NAS faculty

approved, with minor changes, the mission and vision statements included in this report.

In April of 2007 we met with Lloyd Chapin, Vice President and Dean of Faculty at Eckerd. After sharing our motivation and progress, we asked for general advice. Lloyd shared with us that, like the *General Education Review Committee,*[8] this is a multiphase process. He stated that the community of scientists at Eckerd should take hold of this process and infuse the report with as much discussion of curriculum as possible. We agreed and offered that unlike the *General Education Review Committee*, which presented the community a number of alternatives for a universal program, the sciences were looking for a common singular vision to illuminate a path forward. He approved and urged us to think both short and long term and reminded us that the history of Eckerd College has been turbulent but hopeful. From his perspective, he thought the Natural Sciences Collegium was already a curriculum leader on campus by skillfully weaving together interdisciplinary pieces into its program and that we could perhaps also lead in presenting a common vision. He also urged us to reach out to non-scientists and try to find more conduits for interactions with them.

In May of 2007 we had an engaging conversation with John Sullivan, the Vice President and Dean of Admissions at Eckerd College. John spoke about the process of admitting students to Eckerd College. He stressed that students like to know that they can work one on one with a professor, especially in research situations, and that the more research opportunities there are for students the better it will be for the college. John was asked about *Explore Eckerd*, the program where successful student applicants are invited to the campus to better understand the Eckerd approach. He again stressed that "hands-on" experiences showing faculty working with students would make our programs more attractive. The prospective students could then "envision" themselves in those roles. Our committee exchanged creative ideas with John on approaching next year's *Explore Eckerd* venture.

We also discussed with John the students who did not have a stellar academic record in high school but showed glimpses of potential. Could we do more for them? It was mentioned that the BA in Biology is becoming more popular as a less analytical but still highly viable major. Other things mentioned were science communication, science art, science education, and coastal studies. The committee recognized that to help Eckerd do all it can to change lives we need to do more for the group of students who struggle during their first year in the sciences but find their niche later, sometimes in the sciences and sometimes elsewhere. The committee needs to find ways to help this group make any necessary transition as best as we can. John Sullivan was grateful that we were discussing these students also and not only our best and brightest.

Through the process of attending the June 2007 PKAL conference, the group was able to secure a visit from the architect Rayford Law, the *Higher Education Principle* at *KlingStubbins*[23]. Rayford's credentials are impressive. He has designed science buildings at the Massachusetts Institute of Technology, Washington University, and many other campuses. Rayford had an intensive two-day whirlwind visit on the Eckerd campus. He toured all the science buildings twice and met with our committee for an extended period of time. His thoughts were illuminating in that we were candid with him as he was in return. He found much to admire on the Eckerd campus, continually cajoling us to enjoy the spaces between the buildings while at the same time he recognized the poor status of our chemistry and biology laboratories. He motivated us to think about renovating areas in Galbraith, Sheen Biology, and the Sheen auditorium. He also became familiar with the spacial and budgetary analysis of *Paulien and Associates*. He emphasized that this was an important and needed first step to set parameters, especially for a capital campaign. However, the curricular, financial, and architectural aspects of the buildings must be continuously revisited by administrators, faculty members, architects, and campus managers alike.

A subset of the committee (Forys, Junevicus, Weppner) also drove an hour south to visit *New College*[24] in Sarasota. New College built two new science buildings in 2001. In the process of exploring science facilities on the Internet, examining the results of the tours taken by biologist Steve Denison of Eckerd

College during other committee work, by attending a Project Kaleidoscope building conference and separate leadership conference, and by talking in detail to a well-established architect who visited our campus, we developed a good vision of what a top-notch science building entailed. With this knowledge we headed to New College to look at the *R.V. Heiser Natural Science Complex* and the *Pritzker Marine Biology Building*. The Natural Science Complex was finished in 2001 at a cost of 6.6 million dollars. The Chair of the Natural Sciences, Sandra Gilchrist, told us in an interview that began the tour that there were construction overruns and so they had to cut back thirty percent of what they originally envisioned. She said the biggest losses were shared common space and storage space. As we toured the building we were impressed with the modern facilities and infrastructure, the large faculty research areas, and the quantity of teaching laboratories. What was missing was an aesthetic unity. There was no front entrance and no front lobby to celebrate the sciences. Instead, there were two open breezeways that served as entrances that would have been sealed (and common space created) had there been sufficient funds. The teaching spaces in the building were dreary and traditional, with no risks taken, and, for the most part, satisfying New College's needs. Adequate laboratory and faculty space with the required square footage was present, but we saw few common areas and little in the way of natural lighting, studio teaching areas, or interdisciplinary space (photos of New College and other facilities are here[25]). It was a good lesson in how constructing a facility which only minimally satisfies the need for expanded laboratory space and offices can diminish the important goals of improved campus aesthetics, shared community spirit, and faculty morale.

Other Committee Work

Tangent to this committee's work, Eckerd College was invited to submit a million dollar grant proposal to the Howard Hughes Medical Institute in the fall of 2007. Four members of this committee (Flaherty, Grove, Weppner, Wetzel) worked with other NAS faculty on the proposal, playing a formative role in shaping its content.[26] This proved to be an interesting laboratory in which to test the theories we had learned and discussed, and to try to bring them to fruition. Among the ideas included in the Hughes proposal are foundational courses in the biological-based sciences that will serve as a springboard to future course work, a strong emphasis on integrating our cellular and molecular sciences within the curriculum, interdisciplinary hires (e.g., a mathematical biologist), cooperating on an interdisciplinary project (computational biology), partnering with local secondary schools in curriculum and outreach components, expanding our stellar summer research program, increasing our use of newer pedagogies on campus, and classroom renovations to accommodate modern teaching methods.

Our Proposal

Since beginning our work, we were aware that the cornerstone of this first broad curriculum review would be the vision and mission statement. Work on these statements was started in December 2006 and the Eckerd College Natural Sciences Vision and Mission was approved by the Natural Sciences faculty in September of 2007. It guarantees the traditional curriculum as espoused by most science disciplines and also encourages the development of more interdisciplinary interaction and the progressive inclusion of more analytical tools. The concepts for the collegium that follow were those that repeatedly came up during our meetings and were deemed practical to implement at Eckerd in the short and long term. We then discuss our commitment to work closer with the offices of Advancement and Admissions. Although this committee has often discussed the curriculum independent of facilities, we recognize that good facilities are required for us to deliver our curriculum. Through this committee process, we are now better informed and better prepared to discuss with administrators, campus planners, and architects our building vision. This vision is provided in a building statement. We end this section with a short summary that prioritizes this proffer and suggests a plan of procedure.

The Natural Sciences Vision and Mission

The Eckerd College Mission

The mission of Eckerd College is to provide an undergraduate liberal arts education and lifelong learning programs of the highest quality in the unique environment of Florida, within the context of a strong relationship with the Presbyterian Church and in a spirit of innovation.

The Natural Sciences Vision at Eckerd College

To be a leading science program among the nation's liberal arts institutions

The Natural Sciences Mission at Eckerd College

To educate all students in the scientific method and the important ideas of contemporary science; to impart an understanding of the social, economic, and ethical implications of scientific discoveries; to prepare students through in-depth study for careers and advanced study in science, within the context of a broad, ennobling education in the liberal arts, in the unique natural setting of Florida’s Gulf Coast.

We will provide an education in the sciences that allows each student to capitalize on their intellectual strengths and career interests.

Our science majors will:

- acquire excellent analytical and computational skills within their specific scientific discipline
- learn the laboratory and field techniques appropriate to their area
- experience persistent intellectual nurturing through meaningful faculty-student interaction in classroom, mentoring, and research settings

- develop strong oral and written communication skills

- acquire an understanding of the interdisciplinary nature of science through lectures, seminars, and coursework focused on this subject

Our non-science majors will:

- take science courses specifically designed for non-science majors that utilize readings from scientific literature

- increase their scientific literacy through direct exposure to the scientific method, including both analytical reasoning and observation

- develop an understanding of the role of science in the liberal arts

The Science Curriculum in Practice

We need to constantly re-examine this mission to make sure we remain in agreement with it and are meeting its goals to the best of our abilities.

In practice we should continually assess for our non-science majors:

- general guidelines for both our scientific perspective and general education courses which institute increasingly progressive levels of breadth, rigor, and experiment

For our science majors we should strive for:

- smaller classes and laboratories, especially at the introductory level
- a curriculum which motivates and challenges our students in the first year so they strive to reach their full potential as science majors and future science professionals
- a continual strengthening of the recognition of the importance of faculty-student research and structured student internships
- a mechanism by which the growing interdisciplinary nature of the sciences is cultivated within the context of a strong foundational environment

For the long-term health of our Natural Sciences Collegium we need to promote:

- a Natural Sciences structure that monitors curriculum mechanisms, assessment, efficiency, and mission consistency
- a Natural Sciences structure that helps the collegial chair determine our needs and priorities for human resources, building space, instruments
- a working relationship with admissions and the administration to develop methods of attracting motivated students
- a Natural Sciences structure that allows faculty to maintain themselves as active scholars so that they can serve both as role models and mentors to aspiring scientists.

Concepts for the Natural Sciences Collegium for the Future

Strengthen Integrate Bridge

As the NAS Collegium reviewed its overall curriculum, three main themes became apparent: 1) we need to strengthen our individual disciplines and curricula, making each as distinctive and effective as possible, 2) we need to meet the scientific challenges of the future by integrating how we teach science and conduct research, 3) we need to create bridges from NAS to other collegia to create a healthier learning community.

I. Strengthen. A strong NAS in the future will have many well-known disciplines, use cutting-edge teaching techniques, such as case-study-based education, and class sizes that are consistent with our academic mission as a small, liberal arts college. To maximize our existing strengths we will want to take the following steps:

1. Attract the best students through distinctive specialties. The Marine Science discipline and, to lesser degrees, Environmental Studies and Biology, have created distinctive programs that attract students to Eckerd. Chemistry, Computer Science, Mathematics, and Physics contribute greatly to other majors and have much to offer their own majors, but have little room to expand at present, despite the desire to do so. All NAS majors will benefit from evaluating their current strengths and planning for relevant and exciting specialties that work with existing faculty and their future replacements. This is not a short-term goal, but one that would best be reached in the long-term and at the initiative of faculty in all disciplines with support from the collegium and the college.

2. Retain existing majors by improving introductory course sizes. Limiting the size of gateway courses will be good for students, faculty and the Eckerd College community. We propose gradually moving towards limiting introductory classes to 40-44 students per lecture section and having only two lab sections for each lecture. Primarily because of staffing issues, some majors in the sciences have faculty who teach one large lecture class and three smaller laboratory sections. If a lab size is 20 students, this means that lectures commonly have 60 students together, and in times of over-enrollment this number goes higher with lab sizes of 24 students and lectures of 72 or more. Smaller lecture and lab sizes would be good because:

a. it would facilitate faculty using active-learning techniques in the classroom and for in-class discussion.

b. it would enable the faculty to recognize and help freshmen who might get lost in a large group. Attrition from some our majors (e.g., Marine Science, Biology) is very high and often occurs after a large freshman-level course. Sometimes we find that the lost students had the desire and ability to complete the major, but needed a little more help in their first year at Eckerd.

3. Create flexible-style classrooms by renovating Sheen Auditorium and give the option to faculty to move our teaching away from pure traditional lectures and towards active, experiential classes. The SHA auditorium is a medium-sized room with 200 fixed seats that all face a stage. Unfortunately, there have been problems with the acoustics since the room was first built. It is very difficult for both the instructor on the stage to hear the students in the audience and for the students to hear the instructor. This problem is exacerbated by a loud humming noise from an air handler on the room's roof. The room is used primarily for classes ranging in size from 20-70 and is rarely used as an auditorium because of its poor design. As the science curriculum at Eckerd College strives to become more case-study and active-learning based, the problems with teaching in the Sheen Auditorium have become more apparent, because the teacher cannot readily move around the room to talk to students, and the students in their fixed seats cannot easily converse with each other.

We propose renovating SHA Auditorium into two “studio-style” classrooms. One would likely be larger (able to accommodate approximately 60 students) and the other smaller (20-30 students) The studio-style

classroom is an idea that has been taken from the original art studio classrooms and applied with great success to classes throughout the sciences. A studio classroom generally involves students sitting at tables. Students can face a screen if a professor is lecturing (some models use multiple screens), but then turn towards the tables to do collaborative work. Often the tables are equipped with power supplies so that lab equipment can be integrated into the class. We are not seeking to do actual labs in such rooms, but to do applied work within a lecture setting. Carleton College has an excellent website that explains the studio-style concept[27].

4. Create and strengthen ties with external institutions. The Natural Sciences at Eckerd have been very successful establishing and cultivating relationships with external institutions. Students and faculty participate in research projects with institutions like Moffit Cancer Center, Woods Hole Oceanographic Institute, Los Alamos National Laboratory, and NASA's Goddard Space Flight Center, Virgin Islands Environmental Research Station, and several major Florida Universities. Students can explore options not available at Eckerd, but still retrain an Eckerd College degree through programs like our 3-2 engineering program. The Science Curriculum Review Committee recommends continuing and expanding the above activities. We suggest, where appropriate, some internships be formalized into Independent Studies with practicum. Faculty should consider using scientists who are now ASPEC members as resources for valuable contacts. The committee has investigated the possibility of a 3-1 program in petroleum engineering with the University of Stavanger. Such a program, and others like it, would encourage interdisciplinary cooperation at Eckerd in developing appropriate new courses. It would also produce very marketable graduates and alumni with deep pockets.

The Eckerd sciences will soon begin outreach programs for K-12 with Academy Prep Center[28] for Education and Canterbury School of Florida[29]. These programs will send our students to teach in secondary classrooms where they will gain valuable experience and will foster a lifelong commitment to the community. Eckerd College has actively made significant efforts to improve the businesses in the midtown area. Academy Prep, established in 1997 as a non-profit educational center, has slowly and systematically given hope to many of the area's youth, who historically have had a low rate of high school graduation. Canterbury is a private secondary school located in northern St. Petersburg. The school has broken ground on a new marine studies center and is developing strong ties with Eckerd College. The committee recommends further outreach to the community, for example to the Sanderlin Family Services Center located across from Academy Prep and serving the same population; we have a science faculty member on the Board of Trustees.

II. Integrate. Undergraduate science students need a strong foundation in their major, but they also need to be able to communicate and understand other disciplines. Integration among the sciences will be facilitated by the following steps.

1. Foster cross-pollination among NAS disciplines. Reports by national organizations strongly support interdisciplinary learning. Project Kaleidoscope, CUPM (The Committee on the Undergraduate Program in Mathematics), Curriculum Foundations Project, and STEM (Science, Technology, Engineering and Mathematics Education Institute) are unanimous in advocating interdisciplinary learning. Indeed the focus of "Math and Biology 2010" is on "linking Undergraduate Disciplines". The most successful small liberal arts colleges have aggressively pursued interdisciplinary studies. Eckerd already has taken some initial steps. For example, we have eight NAS faculty with dual appointments, six in Marine and Biology, one in Math and Physics and one in Biology and Environmental Studies. We also currently provide some interdisciplinary courses such as: Introduction to Marine Science, which integrates concepts in biology, chemistry, geology, physics, policy, and environmental concerns; the Math-Physics Seminar which shows students the cross application of these two sciences; Bioinformatics, which helps students develop computer science skills in conjunction with today's biological research, and Geographic Information Systems, which integrates geography, computer science, biology and environmental studies. Students are often advised to pursue minors or double majors in allied fields.

This committee recommends a vigorous pursuit of interdisciplinary efforts, a pursuit embodying a spectrum of approaches. Interdisciplinary symposia, colloquia and informal lunches as well as interdisciplinary seminars are suggested. The multi-disciplinary character of science courses can be emphasized and content enriched not only by team teaching but also by the simple artifice of dialogue, problem exchange, and so forth between disciplines. There should be even more emphasis on urging students to minor or double major in allied fields. We also recommend that opportunities be given to explore more interdisciplinary courses that are of great interest to our students and are natural outgrowths of our current programs (example: Neuroscience--to combine interests in psychology, biology, chemistry, physics and computer science. Opportunities for interdisciplinary research should be sought, an added incentive being the current popularity of such research with grant-yielding agencies. At the present time, Eckerd is working on a Howard Hughes Medical Institute proposal involving multiple disciplines, and in it we are pursuing the formation of interdisciplinary minors such as Computational Biology.

2. Create a Natural Sciences Student Symposium Many NAS students do significant research during the summer and academic year, but only a small number of other students and faculty hear about it. We propose an NAS student symposium where students create scientific posters about their research. One ideal time for this would be during prospective student weekend to attract the best future students to all of the NAS disciplines. Additional benefits of the symposium would include good practice for student presenters, a chance for all of NAS to learn about what research is being conducted, a chance to encourage freshman and sophomores to do research, and a vehicle to showcase our best students to potential donors. The symposium would be organized by an interdisciplinary group that consists of one faculty member from each NAS discipline. Posters would be organized by concepts, not by disciplines. These posters could also be used for *Explore Eckerd* and other Advancement and Admissions functions.

3. Design multipurpose laboratories & research facilities. To best use our limited physical resources effectively, when we are able to create new spaces for the sciences we would like to explore the idea of creating laboratories that could be used by a variety of disciplines, but that would also be suitable for lectures. These labs could be designed with bench tables that seat ~4 students, angled to face a common screen. Built into the benches would be power and possibly gas and water connections. Thus, instead of having a separate lab for each subject taught, we envision multiple disciplines using the same labs for a variety of functions throughout the day. Adjacent to these multi-purpose laboratories would be smaller research labs clustered to foster interdisciplinary student-faculty research.

III. Bridge. A liberally educated student should be able to understand the scientific concepts that are likely to affect their lives and the work around them. Science courses are not just for science majors. Several exciting, emerging fields integrate science coursework with courses outside the sciences. The close-knit community of a liberal arts college is the ideal place for majors that not only cross disciplines within the sciences, but across the entire curriculum. To maximize our bridging potential we suggest three steps.

1. Offer more lab experiences in the science academic area courses. Part of the mission of NAS is to "educate all students in the scientific method and the important ideas of contemporary science". Current science academic area courses are primarily lectures without labs, which makes it difficult for students to conduct experiments and do hands-on exercises that increase their understanding of the sciences. Due to staffing and space issues, it is not currently possible to require all Eckerd College students to take a lab class, but we propose:

a. NAS faculty include lab experiences in academic area courses or create lecture+lab courses where possible

b. Faculty who teach NAS academic area classes try to take a case-study, experimental approach where possible, perhaps by teaching in a studio-format classroom (for example in one of the SHA studio classrooms) or by holding the class during a class period that allows field trips and labs.

2. Actively pursuing majors/minors that take advantage of our great strength attracting students to Marine Science and Biology and parlay this into distinctive programs that involve multiple collegia. The Environmental Studies major is a good example of how a distinctive program was formed partially by redirecting Marine Science majors. The following four disciplines are likely to be exciting to students, can be accommodated with few additional faculty, and would be bridges from NAS to other collegia. They could be started as minors that eventually become distinctive majors if they are found to be successful and resources are available.

a. *Science Education*. The scientists of tomorrow are created by dynamic, innovating science teachers in K-12. Approximately 10% of our NAS students already become K-12 teachers. Creating a curriculum that allows students to gain strength in science disciplines while completing courses that make them effective teachers (e.g., psychology, human development, communications courses) would likely be exciting and attractive to many students and would make good use of existing expertise.

b. *Science Communication*. The ability to explain complex scientific issues to the general public is a skill that could be well developed at Eckerd. With our strength in the sciences, communication, film studies, and composition, we are poised to educate students to fill this important niche.

c. *Coastal Management*. Nearly a fourth of the world's population lives on the coasts, and the issues that influence the marine/terrestrial interface require interdisciplinary solutions. A coastal management major or minor would combine our expertise in marine science and environmental studies and its related disciplines (philosophy, political science, economics) to create another distinctive program.

d. *Conservation Biology*. Conservation biologists study biodiversity and how to minimize the impacts of humans on the world to create a better environment for all species. If a few key classes outside the sciences were added to our B.A. in Biology, we would have a new, distinctive program that would retain biology majors who are interested in this field.

e. *Molecular Biology*. From conservation biologist, to medical students, to biophysicists, to biopsychologists, the cellular and molecular sciences are consistently being integrated into nearly all science fields. With our current faculty, exciting courses or minors such as Neuroscience, Biopsychology, or Biophysics would attract excellent students and better prepare our current students for future work in the biosciences.

3. Interdisciplinary efforts should extend to the other collegia. We propose that the Natural Sciences faculty actively seek out other collegia's faculty for team-taught course ideas. We propose more courses similar to the Bryant-Weppner model (religious studies - physics) which attracts students from a variety of disciplines interested in discussing connections between different academic areas. We will write course proposals and will expect the courses to be large enough and alluring enough to justify the team-taught model.

Communication with the Offices of Admissions and Advancement

The Offices of Admissions and Advancement will play vital roles in our efforts to enhance the overall academic program of the Natural Sciences. Indeed, there is a tripartite co-dependence that exists among these entities that must be capitalized upon if we are to realize the full potential of the sciences at Eckerd College.

The Admissions Office is charged with recruiting and ultimately bringing to campus each class of students for the college. In today's extremely competitive admissions climate, recruiting a class of high-quality students in the sciences remains a challenge. Our major in Marine Science is a very popular draw and accounted for almost one-quarter of the 2007-2008 freshman class, and Environmental Studies, Biology, and the allied pre-professional programs also enjoy a very significant interest among incoming students. Unfortunately, the more-quantitative disciplines in the sciences (Chemistry, Computer Science, Mathematics, and Physics) still struggle to attract students to their majors. We believe that the Admissions Office will need to play a very significant role if we are to attract a healthier distribution to all the sciences.

To be successful in attracting and retaining students in any science area, we must highlight features of our programs that distinguish us from other quality liberal arts institutions. In some subjects this can be a significant creative challenge, but it is something that must succeed if we are to recruit from the nation's best students. It is the distinctive features of Eckerd College that will make the offices of Admissions and Advancement the most effective in their efforts on behalf of the Natural Sciences.

We have begun to meet with representatives of the Admissions Office on a regular basis as part of our curriculum review effort. At our most-recent meeting, admissions officers were encouraged to highlight student-faculty research in their conversations with prospective students and, to this end, were provided with a list of Senior Theses[15], and a record of research participants and titles of projects sponsored by the Natural Sciences Summer Research Program[16]. These documents, along with a proposed album that will pictorially portray the exciting elements of our science programs[17], should help Admissions develop a creative, effective approach to recruiting in the sciences. Significantly, we plan to augment our already active participation in the Prospective Student's Weekend by developing the Natural Sciences Student Research Symposium.

We have been working with the Advancement Office for almost a year. Tom Schneider, Associate Vice President for Advancement, has met with members of the Curriculum Review Committee on several occasions. We have decided to develop a brochure for the Natural Sciences[17] that Advancement could use in selling our programs, and we have initiated efforts to construct an NAS web page; the latter will serve as a portal to all the discipline web pages. We are exploring ways that faculty might actively assist Advancement in networking with college alumni, and have extended an invitation to NAS faculty along these lines. Beginning this year, "highlights" have been culled from NAS faculty activity statements and forwarded to Advancement (and Admissions). These highlights will focus on faculty achievements in research, mentoring of student research, publications, and conference presentations.

Science Facilities - Our Statement

Effective Efficient Attractive

Faculty Offer a Voice - Facilities and ecological areas must make the best use of the college's resources. Unfortunately, it is often the case that there are gaps between what is wanted, what is needed, and what can be afforded. Finding the "sweet-spot" in the wants/needs/affordability continuum requires a trusting relationships among the stakeholders. We propose a Natural Sciences representative, what the PKAL documentation refers to as a shepherd[19], to be our liaison and a working partner with the administration and campus building managers in discussions involving new or renovated science facilities and ecological areas located throughout the campus. We offer this representative in good faith as our singular representative voice in the process. By PKAL definition, this person will espouse the needs of the Eckerd science community within the constraints determined by the administration and other campus planners. It is also expected that to attain the needed facilities, a phased approach that includes fund raising, existing facilities renovation and augmentation, and new construction may be needed. A phased approach requires that all constituents are assured that the accepted process will be successfully completed. If the only parameter achieved is a gain in laboratory or office space without the effectiveness, efficiency, and attractiveness that the campus master plan, the administrators, or the scientists envision, it would be better to wait until those goals could be achieved.

Science facilities include lecture rooms, seminar rooms, teaching and research laboratories, equipment areas, and on- and off-campus natural land and marine areas. These myriad venues provide a rich educational environment that attracts many of our science students. Science facilities in general must be effective, efficient and attractive. Many of these characteristics are topics of Project Kaleidoscope meetings and publications.

I. Effective - Effective facilities should support the academic program; encourage educational, scientific and intellectual innovation; and provide a friendly and comfortable environment for collegial interactions. PKAL meetings and documents suggest several factors that increase facilities' effectiveness. These suggestions include unique venues to support various educational pedagogy. The lecture/laboratory/studio facility, which is composed of a presentation "stage," and student discussion and laboratory tables, allows subjects to be presented in lecture with students immediately performing collaborative active exercises and group discussions. MIT's *Introduction to Physics* uses a renovated large room with a central raised area for lecturers and numerous video monitors and cameras for this pedagogy. The Sheen Science Auditorium is in dire need of improvement and could be renovated to provide this type of space. Three of the College's most successful programs — Marine Science, Environment Studies and Biology -- make significant use of the marine and field environments on and near campus which are essential for educational and research programs and also promote good stewardship. Some of these important areas have been compromised by campus development. Without the use of these unique areas, the attractiveness of these programs to potential students may be harmed. To our educational programs, these spaces are at least as important as parking lots and faculty offices.

Connectedness of facilities is also an important issue that was discussed at length at PKAL meetings. "Intellectual Collisions" is how one PKAL participant described informal common meetings of faculty and/or students of various areas of study which support the creative impulse. Places for these collisions can include meeting areas like building lobbies, patio areas, lunchroom/kitchen areas, seminar rooms, and even small open areas adjacent to hallways with comfortable seating and writing boards. For these collisions, it is necessary that faculty and students have their offices and study areas near each other. The collisions can lead to innovative teaching and research activities. The current situation in which Marine Science is located across campus from the offices and laboratories of the other science disciplines severely limits intellectual collisions

and synergy among departments. It is our hope that the placement of any new facility will help alleviate these deficiencies.

II. Efficient - Efficient facilities must make the best use of the college's resources. Science facilities may be some of the most costly resources on campus and therefore must be developed and utilized in ways that optimize their functions. That optimization includes maximizing the use of each laboratory by sharing them during and across semesters. Sharing can be optimized by having departments that would use common resources in close proximity. Related to sharing is the need to develop flexible laboratory and other spaces. Flexibility increases the possibility of laboratory sharing as well as allowing labs to evolve over the years as the needs of science education and research develop. Facilities must be designed to reduce operating costs. Because fume hoods have a significant impact on high vacuum systems, it is suggested that when possible fume hoods should be located in small spaces to reduce their impact on the rest of the building's systems. The LEED certification[30] provides a good baseline for our sustainable designs.

III. Attractive - Attractive facilities ought to provide surroundings that enhance faculty and student morale, that provide a powerful faculty and student recruitment tool, that demonstrate the college's respect for its community members, and that put science on display. Several of the PKAL participants described very successful faculty and student recruitment following new facility development. Certainly Eckerd's experience with student recruitment after the construction of the Galbraith Marine Science Laboratory indicates how new facilities can provide a meaningful return on investment. Some of the most interesting new science facilities have emphasized science in a manner in which the design of the building sees science as the ambiance of the space, not just a place to do science but a place to be surrounded by science. For example, a laboratory which houses unique or special equipment or functions might be designed with windows in corridors to put those on display. Additionally, multimedia descriptions of the operations could be presented on wall-mounted LCD monitors.

Action Statement

Here is the committee's recommendation for prioritizing our curriculum and facility concepts.

Immediate Action

- Form a Natural Sciences Committee to execute the newly-approved NAS mission statement, coordinate future curriculum studies at the discipline level, and establish continual assessment.
- Choose a Natural Sciences "shepherd"[19] to be our representative in the development or renovation of facilities and campus ecological areas related to the sciences.
- Oversee renovation of Sheen Auditorium and other appropriate spaces.
- Create a Natural Sciences Symposium to improve synergy among student researchers and faculty
- Begin limiting enrollment in introductory courses to improve student-faculty interactions and to allow for more active pedagogies.
- Introduce more active-learning workshops into the sciences to promote discussion and cross pollination opportunities.
- Have members of the Natural Sciences approach faculty from other collegia with team-taught course proposals which will be attractive to both faculty and students.

Gradual Action

- Limit enrollment in introductory courses to 40 to improve student learning and retention.
- Improve liaisons with Admissions and Advancement and the Center for Applied Liberal Arts.
- Introduce progressively more hands-on experiences to our non-majors in our science area courses.
- Work with Eckerd's administration to help create more interdisciplinary majors and minors within the sciences as well as more links to other collegia.
- Form a faculty committee to examine ways to promote interdisciplinary classes within and cooperation beyond the sciences.

Long Term Action

- Achieve a healthier distribution of majors at Eckerd College to maximize resources across campus.
- Maintain and extend the Galbraith Marine Science Laboratory to remain a leading undergraduate marine science program.
- Keep the prospects of a progressive celebratory modern science building alive to achieve our mission to be a leading science program among the nation's liberal arts institutions.

Conclusion

With the arrival of Donald Eastman as President of Eckerd College, our institution renewed its focus on achieving goals for the future. By recent initiatives such as the campus master plan and strategic planning[2], President Eastman has demonstrated his steadfast commitment to long-term planning and Eckerd's future. Buoyed by this progression, the President and the Dean of Faculty have recently called for academic reviews of general education and the natural sciences.

This committee has spent ten months in a review of curriculum and building development. We have created a science vision and mission, earnestly discussed interdisciplinary projects and research ideas, become educated on what quality scientific space entails, and acquired procedures followed for many successful science facilities built in the past decade. This is only the beginning of our commitment to a continuing study of science at Eckerd College. The hope is that this discussion will continue under the auspices of the Dean of Faculty and our collegial chair. Another committee should be formed to apply the science vision and mission, attend further conferences, and help the administration, campus managers, and architects plan, fund-raise, and develop our science complex for the 21st century.

Working on this committee was ultimately very rewarding for the participants and, we hope, the efforts of this work will benefit the Natural Sciences Collegium and the Eckerd community at large. We thank the Dean of Faculty for allowing us to embark on this exploration. Because of its merit we urge other collegia to undertake a similar process of curriculum review and reflection. The sciences are one important aspect of liberal arts study in the Eckerd community. As President Eastman pointed out in his Strategic Planning memo of May 2003[31], to survive, Eckerd needs to continually develop and strengthen the entire academic program. A campus-wide academic plan needs to be developed which can only begin after every collegium defines its future and begins to think about the natural conduits that exist between itself and other academic areas. Once the dynamic connections between academic areas are better understood and utilized then we can begin to examine the types of students, facilities, and spaces that will best define Eckerd College in its next fifty years.

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