Transcending Degree Programs

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Key Ideas: (1) Interdisciplinary program, (2) Unique educational/career opportunities, (3) Restructuring school year, (4) Reorganizing managerial structure, (5) Rapid response for research initiative, and (6) Incentive for faculty cooperation.

Abstract

Unique perspective has always been a Mines' strength, as can be seen from our history as a mineral industry educational institution. The exceptional ability to advance core science preparation and then offer radiating degrees in geophysics, geochemistry, and geological engineering has made CSM unique. The concept of preparing a mineral industry engineer to hit the ground running has been our own brand of uniqueness. However, CSM is in danger of becoming an educational and research follower. It is effectively out-of-phase with many new initiatives. Its faculty is not fiscally or culturally encouraged toward out-of-the-box research innovation. Further, interwoven with these hindrances, is the significant effort that is necessary to enlighten and convince high-value donors and foundations of the advantages of supporting our institution. Worse, in light of these difficulties, it could become difficult to attract the pioneering, students that we wish to academically equip and nurture – those who will carry the world's engineering programs into the future.

For us to continue to maintain the important attribute of uniqueness, appealing to and attracting future high-caliber students, faculty, and projects to CSM, we must clearly identify and broaden the application of our unique perspective. A transcending degree program would renovate and energize Mines' students and faculty, allowing us to broaden our scope and serve an extended added-value industry. The proposed transcending degree program could lead the way to better serving the student body with innovative programming and with faculty supported in their dedication to cutting-edge research. Here at Mines we will know we are in a position of excellence when our

programs, our faculty, and our students are establishing the research roadmap. We must strive to be in this position and a transcending degree program can focus our travels.

I. Introduction

> It is change, continuing change, inevitable change, that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be….
>
> -Isaac Asimov

With a significant fraction of the faculty now coming to Mines from a non-mineral-based experience and preparation, the impact of this new culture is being felt. Realizing that change is the natural cycle of life and that these new faculty bring new possibilities, this paper presents recognition of what we should hope to preserve as we make changes and, second, suggests the institutional changes that are required to achieve our continued uniqueness as an institution.

A unique perspective has always been a Mines' strength, as we see from our history as a mineral industry educational institution. The exceptional ability to advance core science preparation and then offer radiating degrees in geophysics, geochemistry, and geological engineering has made CSM unique. We have offered interdisciplinary degrees which clearly identified a special preparation for a specific industry – degree programs in mineral economics, petroleum refining, physical metallurgy, chemical metallurgy, geophysics, geochemistry, etc. Our degrees represented a sound preparation in a discipline subject and significant preparation in a related applied subject. The concept of preparing a mineral industry engineer to hit the ground running has been our own brand of uniqueness. We stood out from other institutions and students identified with this difference in preparation and found that industries sought their talent. The students knew the career path that they were studying and industry knew what they were hiring. Past CSM successes include transporting Colorado youth into the world

economy, international recognition, production of corporate, government, and academic leaders, and world-class research.

As time has passed and the Mines faculty has changed, each new faculty member has brought his or her own experiences and enriched Mines' culture. Mines has the most creative, highest quality faculty ever. However, inevitably, in the process the expectations drawn from other educational backgrounds have been laid across the Mines paradigm. In some cases, this shift in thought has obscured those practices and philosophies that have made Mines unique and successful. One example is that in many cases the adjective description of degrees have been eliminated, with geochemistry becoming chemistry, petroleum refining becoming chemical engineering, mineral economics becoming economics, and chemical and physical metallurgy and ceramics becoming materials science. These changes were made with good intentions, especially with the idea that our institution might not be able to compete unless it presents its programs like those offered in other institutions. However, the fact is that when we portray ourselves as a small institution with programs identical to large institutions, we become comparatively expensive in our offering a competitive product. This direction will most likely lead to our eventual incorporation into a large university. Mines must offer unique programs and experiences to have a future place in the marketplace.

What we need to recognize is that we should produce specific interdisciplinary undergraduate and graduate degree programs and not generalize our identity. This paper suggests a framework for such degreed programs and identifies the practices that hinder interdisciplinary degree programs. Further, it suggests solutions that promote

unique, leading-edge programs and that also promote a climate in which faculty members, as well as students, gain – both intellectually and economically – in being part of such programs.

There are many methods to create, operate, and phase-in interdisciplinary programs in a timely response to regional and national needs. Interdisciplinary programs are an "open-ended issue" and such flexibility should be preserved. This paper presents some actions that would move CSM in a better direction. Some suggested initiatives may at first glance seem difficult – even threatening – to different segments of our present culture. Change is seldom initially comfortable but the goal here has been to look to the future and envision an institution, and a culture, which can respond energetically and positively to new possibilities. Time has been spent investigating these ideas and it is hoped that some of them could be further developed into a meaningful roadmap for creating a unique and worthwhile educational experience. There are many positive reasons to consider and anticipate a transcending degree program in Mines' future.

II. Goals

In today's competitive educational climate, an engineering college must exhibit several attributes of excellence in order to stand above the crowd. When the college is small, perhaps only 3000 students (or about the size of an inner-city high school), the school's consistent reputation for and promise of an exemplary education becomes even more important. When considered critically, it becomes clear that there are three attributes in particular that shape and define educational excellence: (1) a school-wide

dedication to the highest quality program, (2) a community of scholars, and (3) a unique – and often cutting-edge – perspective.

A high quality program, which guides and promotes lifelong learning, must focus on sound and thorough preparation in science, mathematics, and engineering science courses and on an education that is based on lectures, tutorials and laboratory experience. Such a program requires depth of knowledge in fundamentals, establishing a command of topic, and not merely the student as an operator or an experience of the topic without drill. The use of an equation as a formula or the blind use of computer software will not lay the groundwork for lifelong learning. When the student understands an equation as a mathematical expression of a concept or describes the physics and behavior of matter, then the student has achieved a position from which he or she can build.

In order to maintain a forward-thinking institution of this sort, CSM must nurture its community of scholars. Faculty, post-doctoral and visiting scientists, graduate students, and undergraduates must all be searching for answers to well thought-out questions, enlightening each other through discussion, attending seminars, reporting on their travels and experiences, reading the literature, critically assessing their work, and sharing ideas.

Drawing from our past successes, we can further apply the unique CSM perspective in new radiating – or, indeed, transcending – programs. These transcending programs will suggest a strong major study area with some secondary, well-focused interest studies. This secondary area will be larger than the traditional "minor" and will allow the student to extend the application of his or her expertise beyond a single field of

study. We have already had a transcending degree program where "geo-" has been coupled with physics or chemistry, "resource" with geology, and in programs such as petroleum refining, extractive metallurgy, engineering physics, etc. It is time to take the initiative to expand and clearly formalize the transcending program model into areas that are in phase with the interests and needs of both Colorado's future graduates and the world's evolving industries. Likely transcending programs would include biomaterials, electronic materials, energy economics, opto-electronics, computational chemistry, polymer manufacturing, etc. Each new student would first seek out a discipline course program and then add another set of solid science, mathematics, and engineering science courses for a secondary discipline-transcending topical emphasis. CSM would encourage new students to enrich their first dream with this selected specialty. If the professional world is becoming an ensemble of specialties, then let our students find, explore and excel in their niche. A transcending degree program respects students' individuality and opens a welcoming door to exciting cross-discipline research and applications.

Table I lists some examples of primary disciplines. The student would select from this type of list. Then the student will select the transcending field from the list on Table II. Taken together, for example, one could select Refining Processing, Geochemistry, Compu-manufacturing, Bio-computing, etc. Some of these primary disciplines with transcending fields are illustrated in Figure 1. The courses exist in the present curriculum and will not need new introduction, except perhaps in an area involving biology.

TABLE I Primary Disciplines

Students will select one primary discipline from the topics below:

- **Chemistry**
- **Economics**
- **Engineering**
- **Fuels**
- **Geology**
- **Management**
- **Manufacturing**
- **Materials**
- **Mechanics**
- **Mining**
- **Physics**
- **Policy**
- **Processing**
- **Recycling**

TABLE II Transcending Fields

Students may select one transcending field from the topics below (shown as descriptive prefixes):

- **Bio**
- **Chemical**
- **Compu-**
- **Electro-**
- **Environmental**
- **Geo-**
- **Mathematical**
- **Microelectric**
- **Nuclear**
- **Opto-**
- **Petroleum**
- **Physio-**
- **Polymer**
- **Refining**
- **Resource**
- **Structural**

Each selected transcending field would have a specific set of required courses and a few electives. The transcending topic should identify utility.

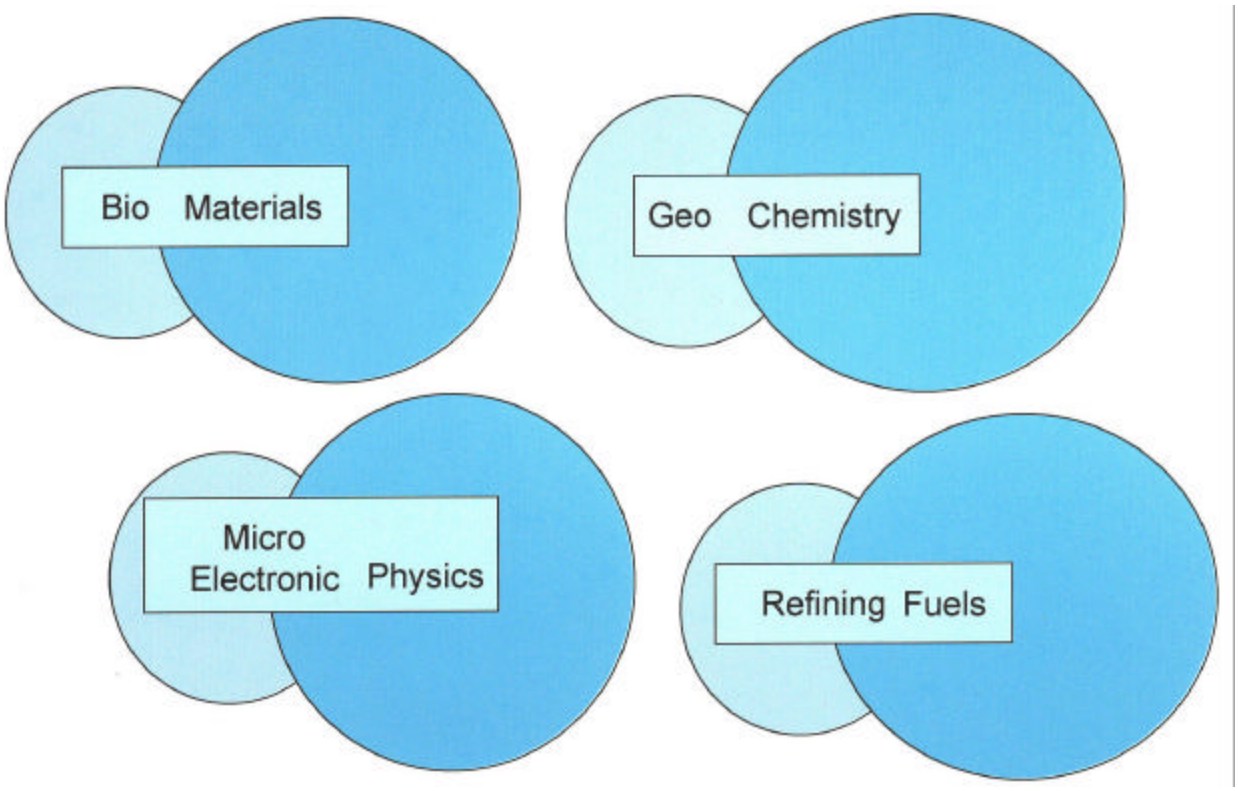

Figure 1. Primary disciplines with transcending degree fields

An example of a transcending course program is illustrated in Figure 2. Notice that this program has a total of 39 semesters hours in the primary discipline and 27 semester hours in the transcending field area. The transcending field is larger than the present minor degree program. The total number of semester credit hours is 128 hours, which is much lower than the present program.

As with any major institutional change, there also needs to be a place for each faculty member to contribute and grow. It is important that a significant percentage of the faculty accepts the plan and there must be a managerial plan to support the faculty through reward systems that promote working together. The administration will be

responsible for creating the laboratory, library, computation system, and staff support needed to facilitate these changes. This transcending interdisciplinary program will require a significant amount of student advising and student support to assure a meaningful experience. Some of the obstacles of the transcending degree program are described in the following section.

A. Primary Discipline	30 hours
A. 1. Engineering Science (discipline specific)	9 hours
B. Transcending Field	27 hours
SUBTOTAL (A + B)	**66 hours**
C. Common	
C. 1. Mathematics	18 hours
C. 2. Physics (1st year)	10 hours
C. 3. Chemistry (1st year)	4 hours
C. 4. Communication Skills (includes English and computer skills)	12 hours
C. 5. Society (economics, environment, civics, and three other cultural enriching courses)	18 hours
SUBTOTAL (C)	**62 hours**
GRAND TOTAL (all credit hours)	**128 hours**

Figure 2. An example of a transcending course program.

III. Factors Detrimental to Interdisciplinary Programs

There are a number of factors, which reduce the desire for a faculty or staff member to take part in interdisciplinary activities. These factors are:

A. The 37-week faculty contract

B. The partitioning of the institutional budget

C. The time and effort required for faculty renewal

D. The department heads' award system

E. Difficulty with institutional investment

F. The proper phasing in investment for program enlightenment

Let us address each of these six factors:

A. The 37-Week Contract

The 37-week contract for university faculty and teachers in K-12 education was an integral part of our agrarian past. Since before farm machinery, students constituted a significant fraction of the labor force. Fifteen weeks of the late spring and most of the summer was, by necessity, not available for institutional education. The result of this 37-week contract was that during the non-contracted weeks the educator either took part in this agricultural enterprise or in some other financially enriching activity. The 37-week contract is out-of-date and is a primary hindrance toward faculty members working together. To have an annual salary competitive with his/her industrial colleagues, a faculty member needs to seek work during the 15-week summer period. Most

engineering faculty members are busy during the 37-week academic period writing proposals and firming up outside work to recover the remaining 15 weeks of salary. This additional salary comes from various segments, either from a number of separate research contracts and/or teaching summer courses and consulting. Some members are even gone during part or all of the 15-week period working in industry, similar to their agrarian ancestors. Faculty absence for an excessive period is very disruptive to academic progress and research, particularly to the graduate students.

With the present arrangement of a 37-week contract, the faculty and departmental focus is, by necessity, on individual needs. The board should realize that it is a faculty member's family responsibility to be fully employed. As the faculty member is seeking this summer support, he or she needs to focus on personal interests in order to maximize the number of weeks collected for the upcoming summer. This results in a limited faculty involvement in multiple investigation projects. The problem grows worse for the more senior and experienced faculty members because they are more expensive and require more disciplinary-type projects to cover their summer. A strain is imposed on what should be a healthy partnership as junior faculty members phase into the field of more established and experienced faculty members. This situation leaves the junior faculty members on their own, further encouraging faculty members to pursue economic survival through the building of a narrow individual expertise and promoting a culture of not working, or even communicating, with other faculty members.

B. Partitioning of the Institutional Budget

CSM currently has no financial driving force to encourage working together. Investment defines a program. If investment is made to departments, then departments have motivation to keep it in-house.

Also, with this arrangement each department tends to have its own supporting facilities such as machine shops, chemical labs, etc. This impacts the effective use of supporting technical staff and causes redundancy in expenditures. It fosters a non-interdisciplinary behavior even in staff. Also, the budget should be implemented for more effective use of facilities and support staff.

C. Faculty Renewal

The faculty needs more incentive for continual faculty renewal. The investment in innovation is now limited. There is a need for faculty preparation for continual leading edge performance.

D. Departmental Heads' Award System

Department heads get their recognition from numbers: the number of students in their program, completed degrees at each level, building a faculty of specific expertise to cover the discipline, research award volume, and high satisfaction ratings from graduating seniors as seen by course evaluations and exit interviews. From a practical standpoint, this performance needs to occur within acceptable economics. Having faculty, staff and new students work with other departments does nothing to support the

department head's objectives and milestones. A department head is left with no motivation to encourage interdisciplinary activities.

E. Difficulty with Institutional Investment

With CSM continually revising its programs to be similar in title and nature to other institutions, it has become more difficult for the institution development personnel to enlighten and convince high-value donors and foundations to support our institution. A small school must clearly illustrate uniqueness and quality.

F. Need for Proper Phasing in Investment for Program Enlightenment

CSM is becoming an educational and research follower. It is effectively out-of-phase with new initiatives – we are becoming a Johnny-come-lately institution. Nano-materials were already funded projects by the time we decided to become involved. For hydrogen storage fuel cells research, we are still trying to catch the wagon. CSM has become a follower. We need to get in-phase at the beginning of new initiatives. These new initiatives are most likely going to be of an interdisciplinary nature. CSM needs a school culture that can rapidly seek and address new initiatives. These new initiatives demand scopes that are larger than the faculty members. We will know we are in a position of excellence when we are establishing the research roadmap. We must strive to be in this position.

IV. Solutions to Hindrances

A. Tri-Semester Year

(Solution to the problems presented by the current 37-week faculty contract)

The tri-semester year would be partitioned into three 15-week teaching periods, which are separated by the remaining seven weeks. These remaining seven weeks would leave three weeks for the holiday/new year period, two weeks in the spring and two weeks in the late summer. The tri-semester year can be configured in many ways, depending on the institution's objectives and the schedule's appeal to new applicants and their families. A tri-semester year offers new possibilities for both the undergraduate and graduate degree programs. Three possible configurations of the partition of the year into three semesters are shown in Figures 3, 4, and 5. In all of the figures, the undergraduate can complete the BS degree program in three years.

The rapid and direct approach is illustrated in Figure 3. This approach has the undergraduate entering in August and finishing three years later in May. This configuration does allow for a 3-4 year BS-MS degree program where the student completes a Masters degree thesis in the four remaining semesters, which would make up the fourth year. With the Masters degree becoming the preferred hire for many industries, this configuration could be very attractive for the student who is seeking the most rapid, economical, and time-efficient track to an industrial career position. His continual study program also offers significant savings in time (and therefore money) for the student receiving family support.

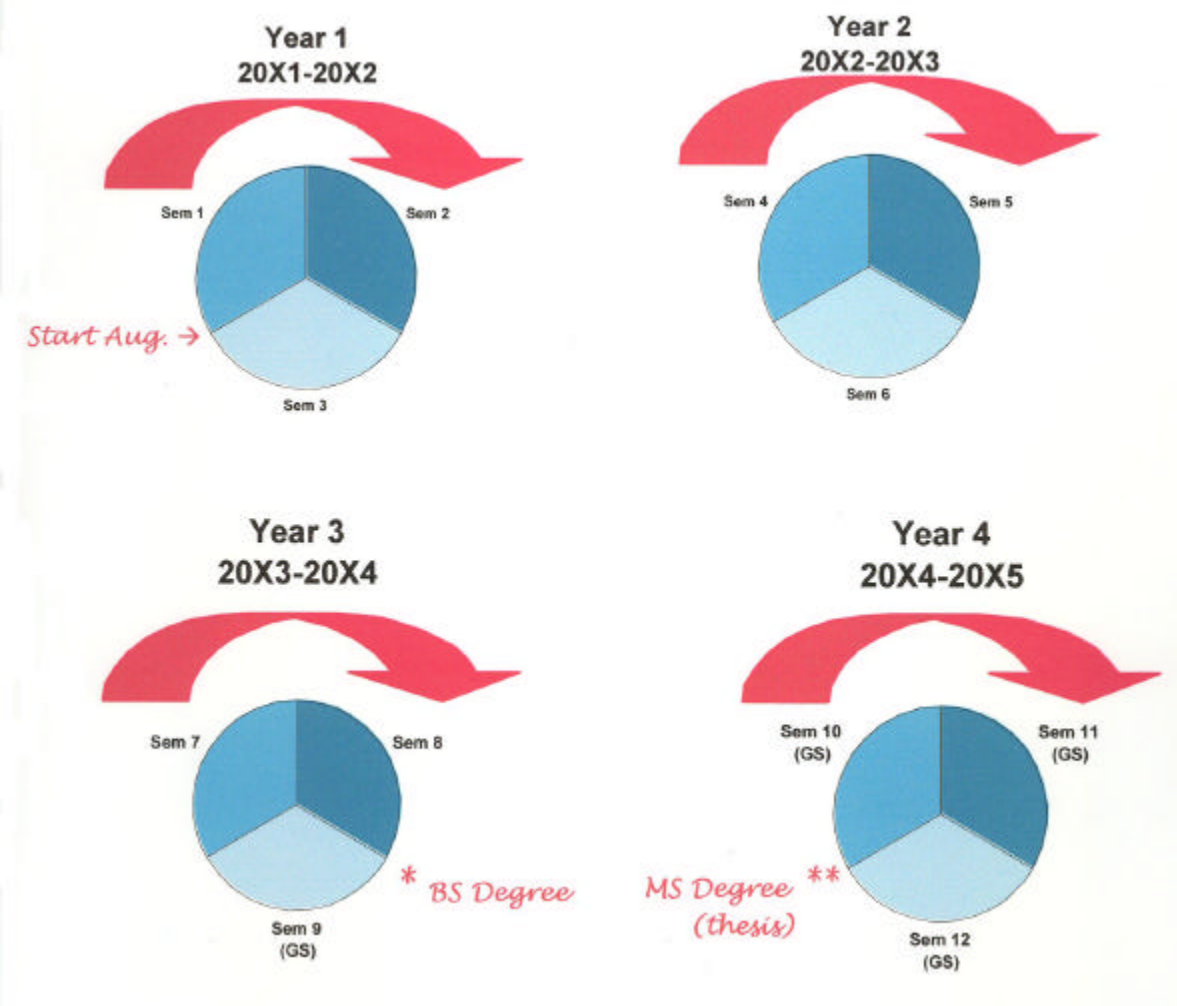

Figure 3. Transcending Degree Program: BS and MS (thesis) degree program in a four year plan.

Figure 4 illustrates a BS degree program with a semester of enrichment between the seventh and eighth semesters for an industrial, national laboratory, international study and travel, or field camp experience. In this configuration, the student still completes the BS degree program in three years. This configuration also leaves room for a well-designed MS (non-thesis) degree program in the remaining semesters of the third and fourth year.

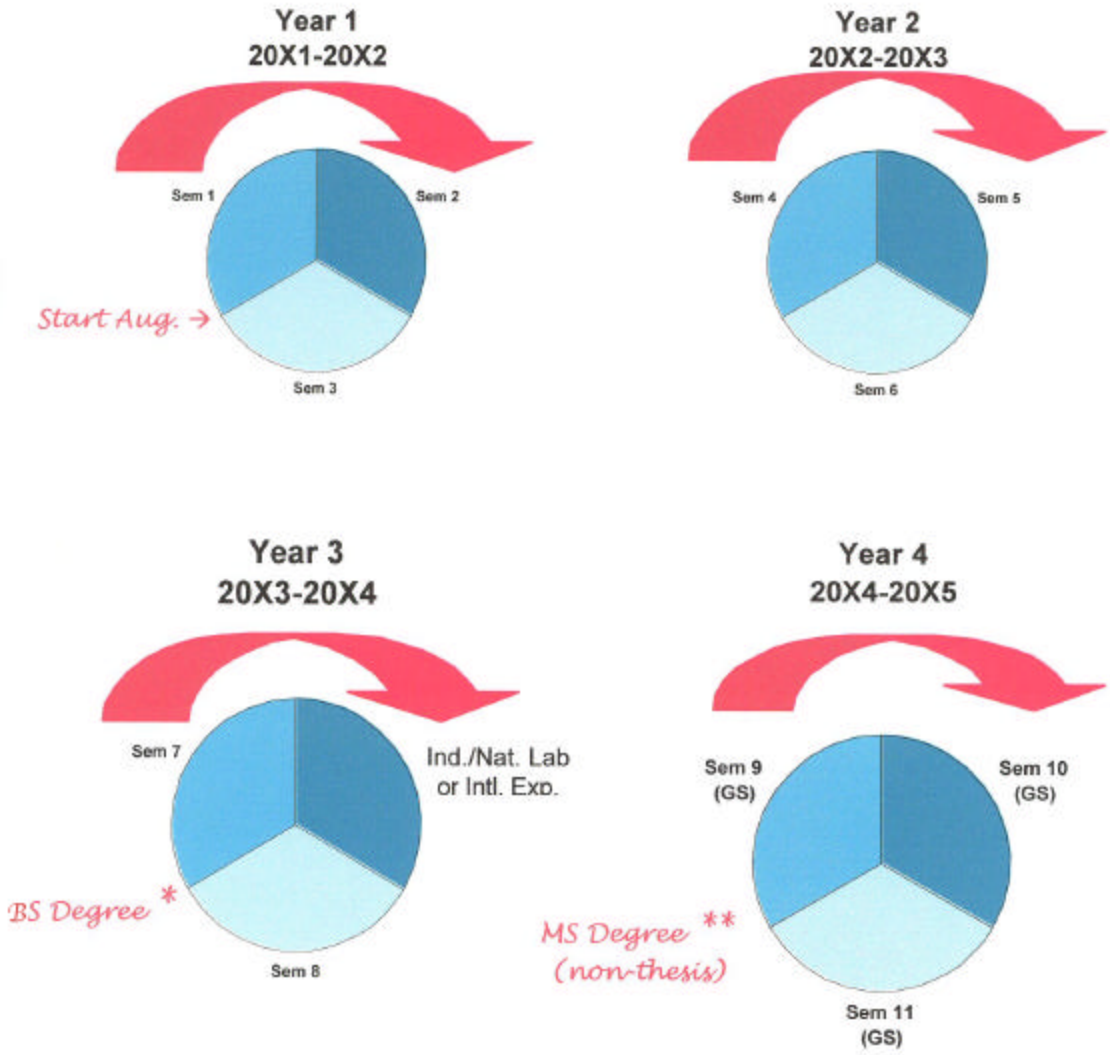

Figure 4. BS, Co-op, and/or International experience and non-thesis MS degree program in a four year plan.

Figure 5 illustrates a plan where, after eight continuous semesters, three semesters are available for completion of a non-thesis MS degree. This configuration is the most direct approach and would have the new undergraduate student starting the BS program in May of the first year and completing a BS and non-thesis MS degree in a total of 11 semesters.

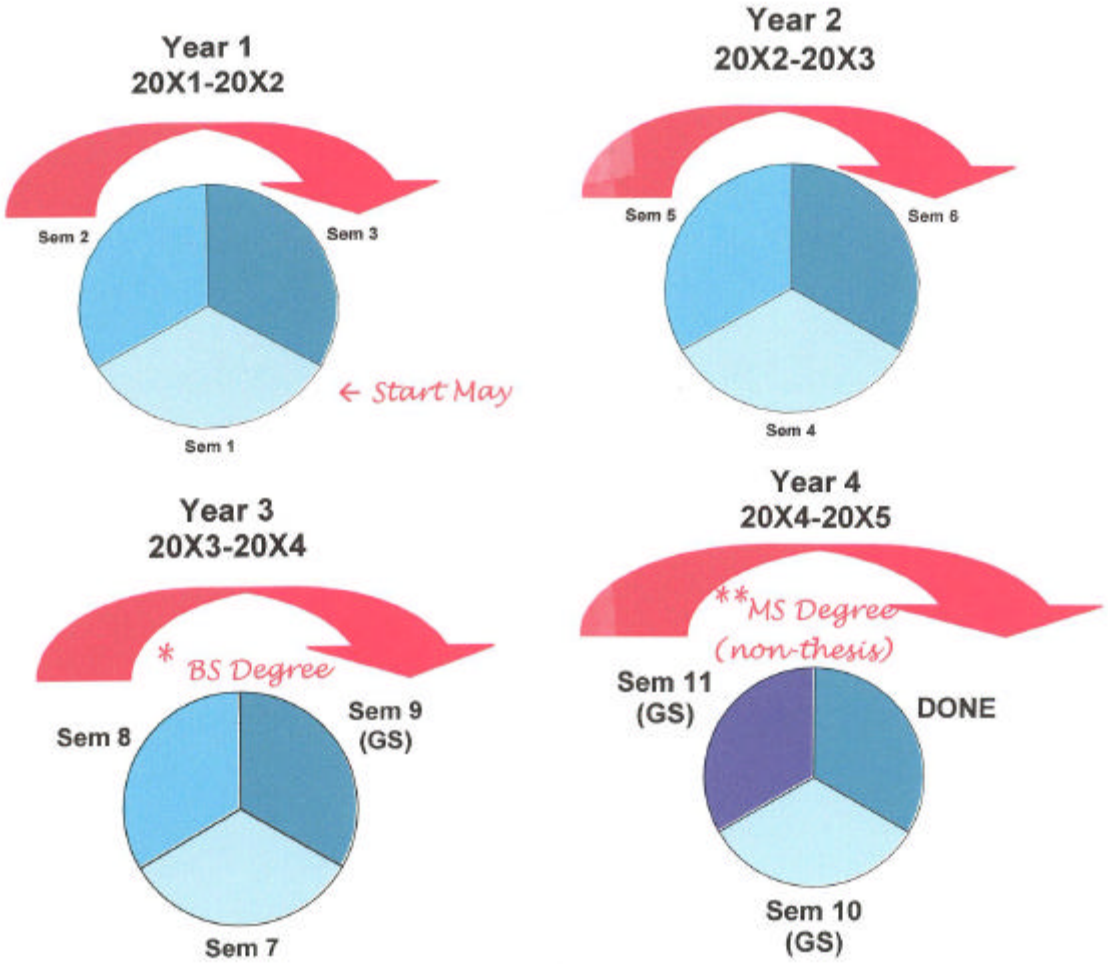

Figure 5. BS and MS (non-thesis) degree in 11 semesters (most direct approach)

With careful analysis and the availability of some courses more than one semester during the year, it should be possible for a new undergraduate student to select one of these three options.

The tri-semester year supports the full-year faculty contract, which as discussed earlier, offers less hindrance for a faculty member in pursuit of interdisciplinary and cooperative work with other faculty members. There would be no financial barriers for faculty cooperation. A tri-semester year will also achieve full utilization of the faculty, staff and facilities.

This accelerated educational approach should be received well by families who can maintain the student's focus on education without the interruptions of changing apartments and moving/storing personal property caused by the summer recess. Very few student summer jobs can produce an income sufficient for the tuition and learning experience expense under the present two-semester arrangement? in many cases the summer period is ultimately a financial expense. The flexibility of the tri-semester year would also support students who, for whatever personal or financial reasons, need to take off a semester. The tri-semester program would also easily serve students who would prefer the traditional four-year undergraduate program by not enrolling in summer classes.

The tri-semester system would keep the students focused and permit the students to finish in three years, allowing for a 3-4 year (BS and MS) program to be completed in the traditional four year BS time frame. The fourth year for a master's degree would put CSM ahead of the pack because it is becoming evident that the master's degree is the preferred hire and is really, with today's required knowledge and skill base, the first engineering degree. The traditional BS degree is quickly becoming a preliminary engineering degree. With accreditation boards taking a more serious look at the Masters degree as the first professional degree, CSM needs to establish itself as an exemplary school by being the first with this evolutionary transition.

The transcending program would work best using a tri-semester year. This approach would mean that the faculty members would receive a 12-month contract. A full-year contract would promote a better focus on collaboration between faculty

members instead of the current contract, which requires faculty to concern themselves with procuring a full year's salary. The tri-semester year would be more likely to keep faculty on campus and performing school business during the summer. Additionally, salary budgeted for research could be moved from faculty support to student support. This budget shift would allow for more graduate students at Mines.

B. Investing the Institutional Budget

(Solution to the problems resulting from the current partitioning of the institutional budget)

An institution is controlled by the method by which the resources are divided up. To have the budget promote interdisciplinary activities and encourage faculty to desire to be part of interdisciplinary degree programs, a new operating structure needs to be established. As for any open-ended problem, there are many solutions for partitioning and delivery of the budget.

Let us consider how the resources are delivered for the manufacturing of an advanced technical assembly, such as an aircraft. Here the budget is divided up so neither the department heads nor the program (managers) have enough money to pay for the technical staff and operational expenses to make the product. They must work together to get their interdisciplinary task completed.

How would this work for an educational institution that has premier interdisciplinary degree granting programs? The institution needs to have two different groups of managers: Department Heads and Program Managers. Departments exist as wellsprings for the school’s resources – faculty and facilities grouped by expertise. The

department heads are responsible for their department's faculty, staff, and facilities. The Program Managers are responsible for our product, the student. Therefore, the program managers are in charge of the degree granting educational programs, promotion for students, student involvement and advising, quality of their programs, promotion of research funding, scholarships, promotion of career opportunities, etc. The program managers are in charge of activities and the department heads are concerned with facilities and personnel. To pay for the department facilities, faculty and staff, the department head contracts out faculty, staff and facilities to the program managers with programs having the significant part (2/3) of the institutional budget. The departments' heads have 1/3 of the institutional budget to cover staff and facilities expenses. The department heads and program managers will negotiate the faculty involvement in each interdisciplinary project. Each program manager's budget allotment toward faculty will be related to student involvement in that project.

This approach seems to be in place with the times, treating the university as a sort of free marketplace. The interdisciplinary programs will come and go depending on their ability to contribute talent and research to today's industry, just as an aircraft firm phases out the production of the F-15 fighter aircraft and brings in a new program manager to produce the strike fighter. The Program Managers will be teaching faculty members.

There may be reasons to have various disciplinary programs within the science departments of the institution but these disciplinary programs need to be very selective in choosing the students (with an eye toward graduate school) and not be a significant part of the institution's mission and activities. Even here the students should have some

interdisciplinary exposure with a minor in one of the interdisciplinary programs.

C. Continual Faculty Renewal

(Solution to the difficulty of faculty renewal)

If faculty members are to be active participants in interdisciplinary programs, there needs to be an acceptable academic culture available. For example, the bio-materials program needs faculty to cross disciplinary lines and the faculty member needs to have sufficient time to be a contributing member. This effort will require institutional investment in faculty so that they can expand their expertise and become competent in a sufficient number of the fundamental and technological concepts and practices to allow them to make a significant contribution. This further education, which can be accomplished through either continual practice or intense periods of study, needs to be a requirement for faculty growth at CSM. The faculty renewal program would have to be more intense than the present CSM sabbatical program. Every faculty member should be required to take a sabbatical every seven years or present an equivalent plan of renewal, perhaps based on a very active continual educational experiences. A faculty career needs to be made up of at least three sabbatical experiences and they need to be a part of the faculty promotion milestone. Such a faculty renewal program will have to be part of the institutional investment in its faculty assets.

D. Encouraging Interdisciplinary Forces

(Solution to the department heads' award system)

Separating the department heads' responsibilities from those of student programs can be achieved by establishing a program management system similar to that used in the manufacturing of complex technical systems. Separation of facilities and faculty management from student programs promotes interdisciplinary activity.

It is important to allow the students to benefit from all of Mines' fine faculty, including the humanities. Each program manager needs an active humanities consultant to ensure that the program has insight. Ethics, psychology, communication, and other humanities are important in considering the relevance of the sciences to the human experience and to finding new scientific solutions to human concerns.

E. New Organizational Structure for the Transcending Degree Program

Figure 6 illustrates a possible organization structure for an institution using the suggested discussion of having separate responsibilities for Departmental Heads and Program Managers. The Provost would have a VP of Faculty and Facilities and a VP for Student Programs. The Division Deans report to the VP of Faculty and Facilities, while the Program Directors report to the VP of Student Programs. Department Heads report to Division Deans and the Program Managers report to the Group Director. Figures 7 through 9 illustrate how the various Departments might report to a specific Division. Figures 10 through 17 illustrate how the various programs (Program Managers) might report to the Group Directors. Notice that Group VIII is for the undergraduate Common Core Programs. Figure 18 proposes the reporting arrangement for the Dean of Undergraduate Studies and Life and the Dean of Graduate Studies and Life and the

Associate VP of Research Development.

F. Graduate Programs

The transcending degree programs would extend into the graduate programs, which include the 4-5 year BS-MS degree programs as well as the Master and PhD degree programs. The graduate students would also report to an advisor who is working in one of the transcending programs, such as Thin Film Material Science, Bio-materials, Welding and Joining Metallurgy, Fuel Cell Materials, Fuel Cell Chemistry, etc. These programs would be organized by a program management team.

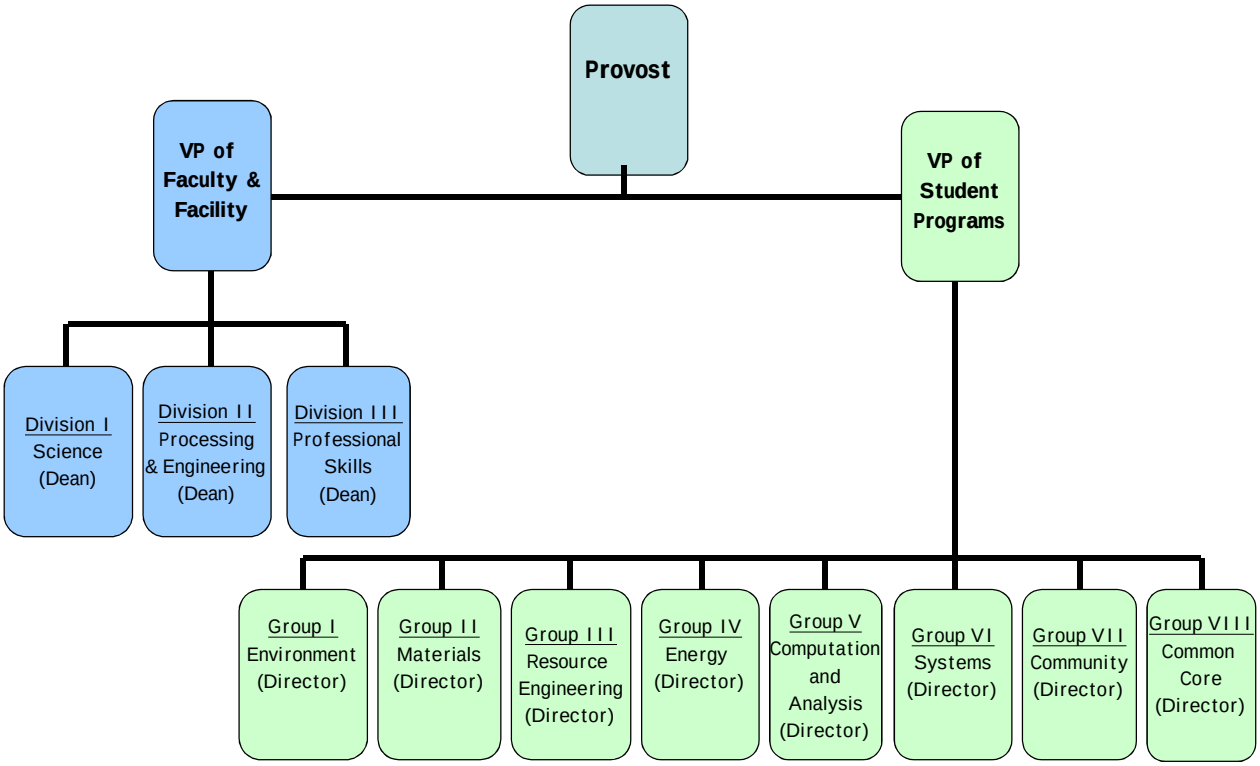

Figure 6. Transcending degree programs: Organizational Structure

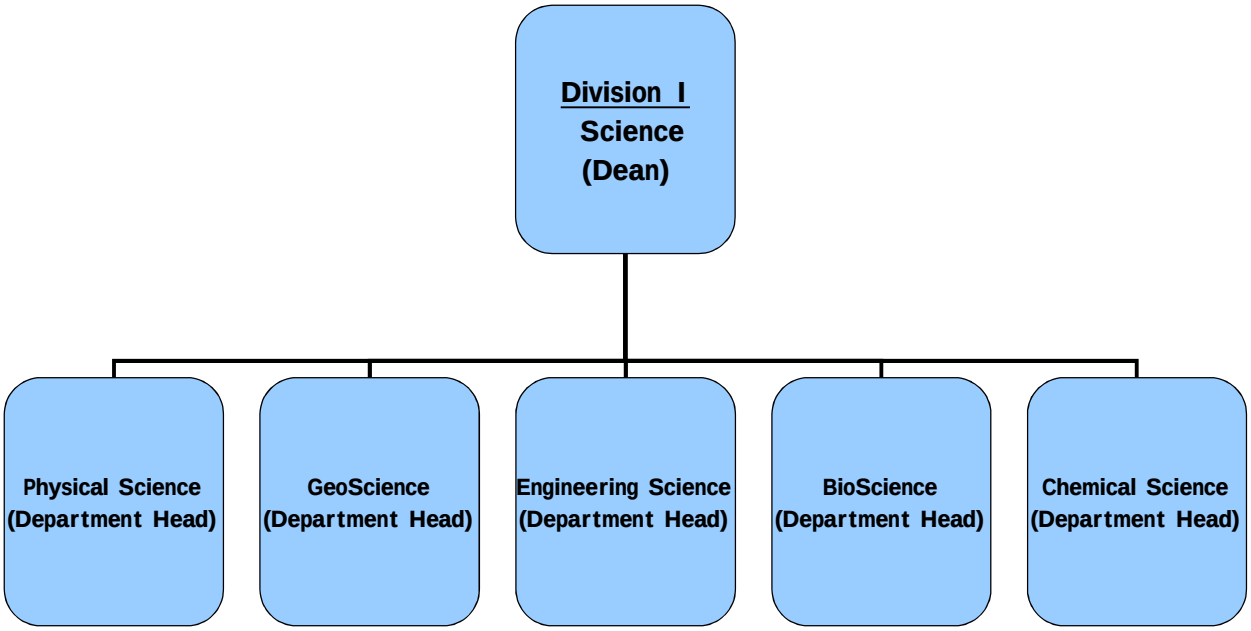

Figure 7. Transcending degree programs: Departmental Organizational Structure

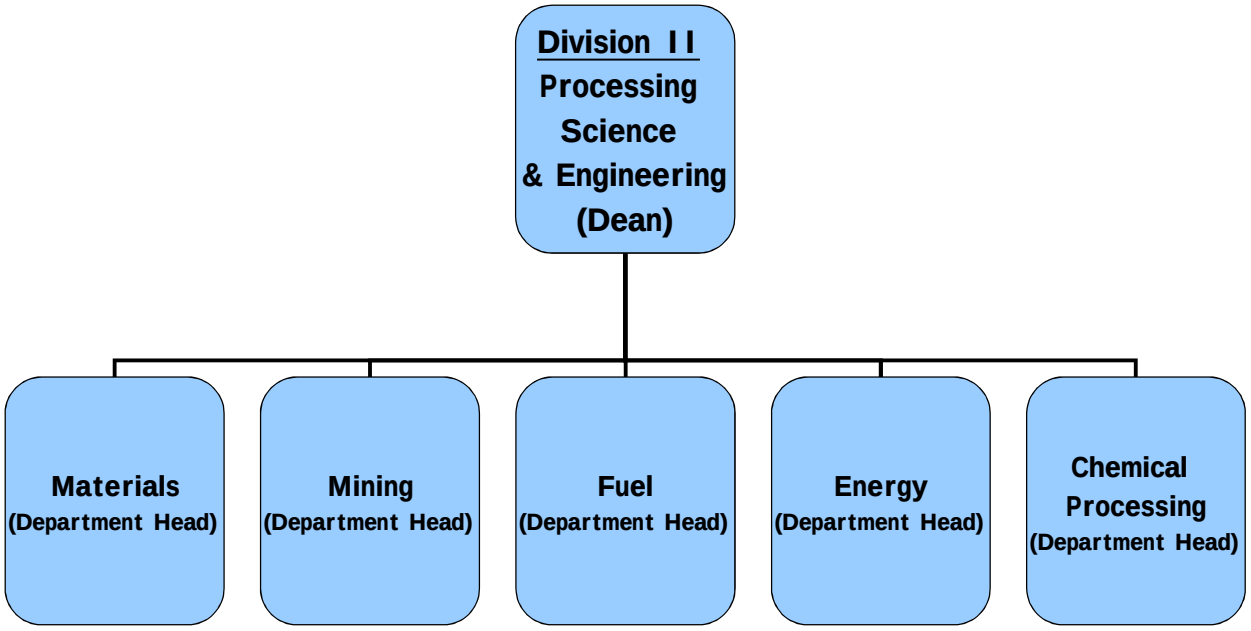

Figure 8. Transcending degree programs: Departmental Organizational Structure

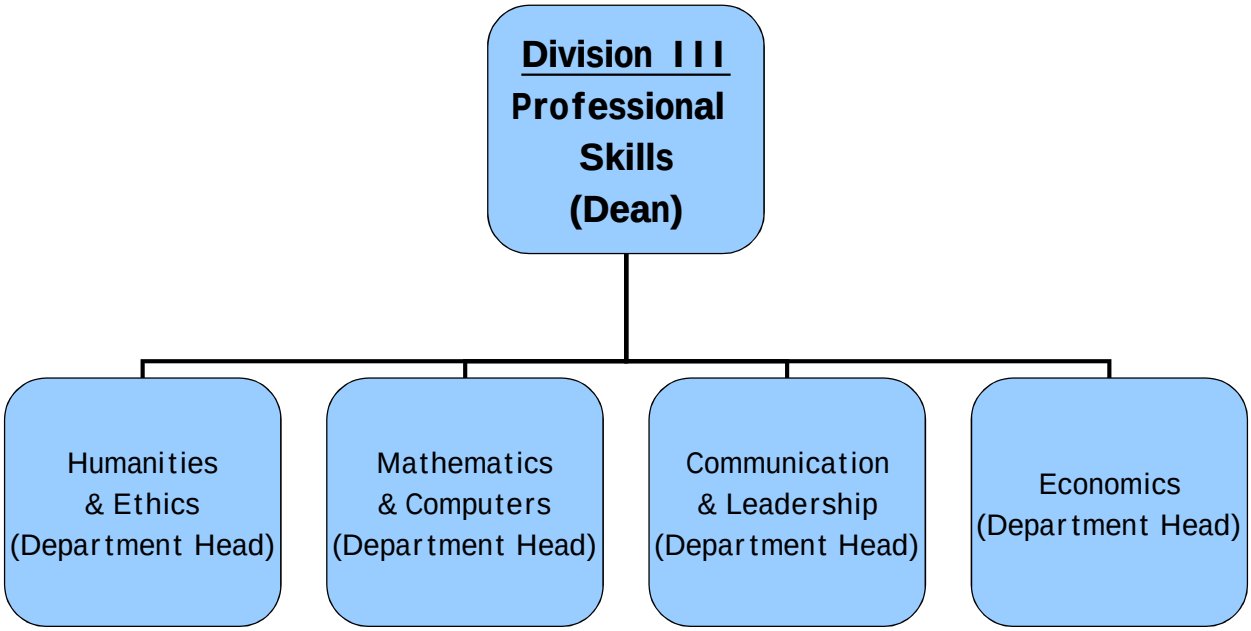

Figure 9. Transcending degree programs: Departmental Organizational Structure

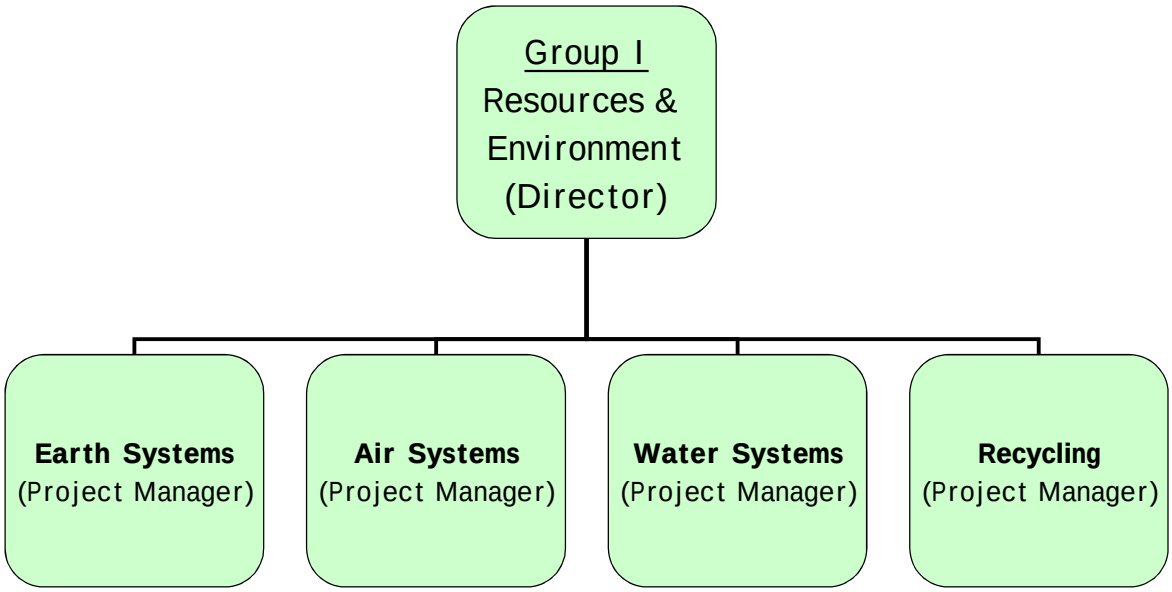

Figure 10. Transcending degree program: Programming Organizational Structure

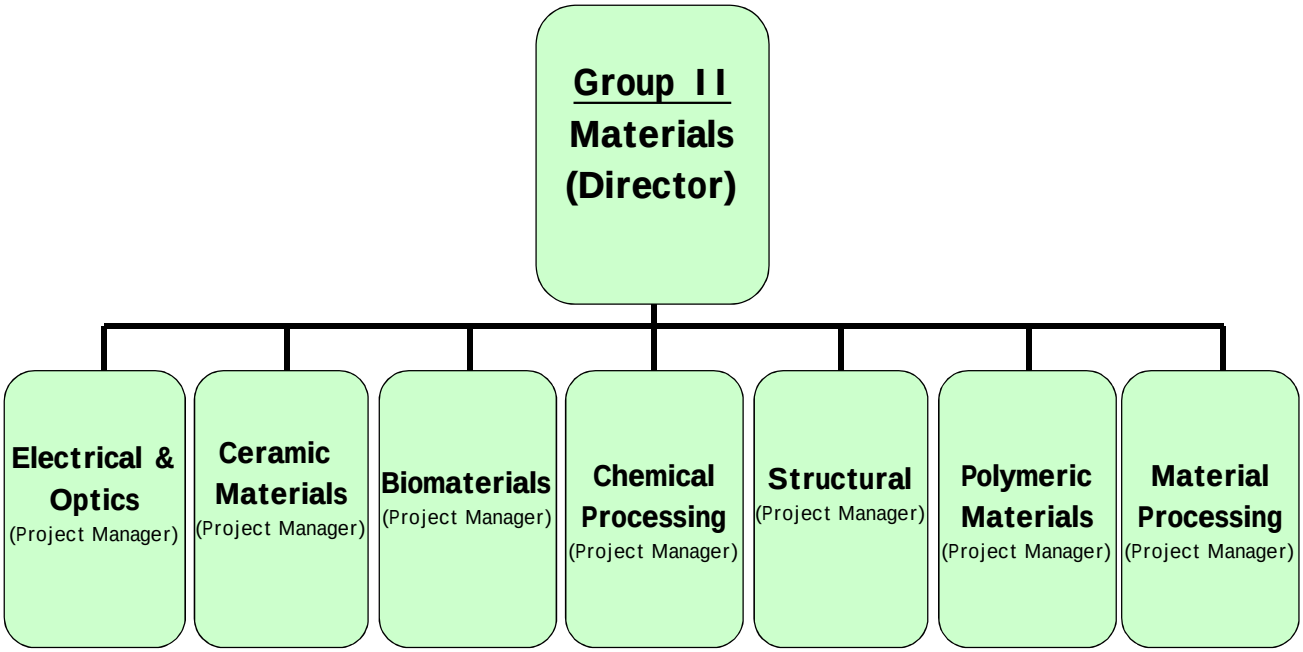

Figure 11. Transcending degree program: Programming Organizational Structure

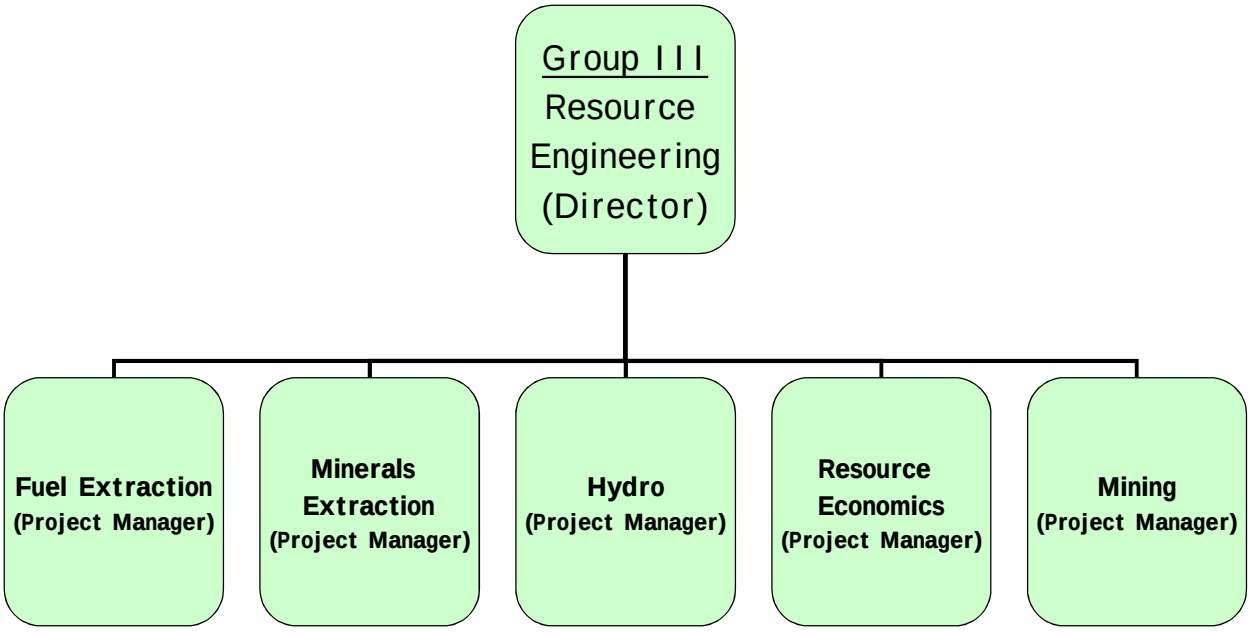

Figure 12. Transcending degree program: Programming Organizational Structure

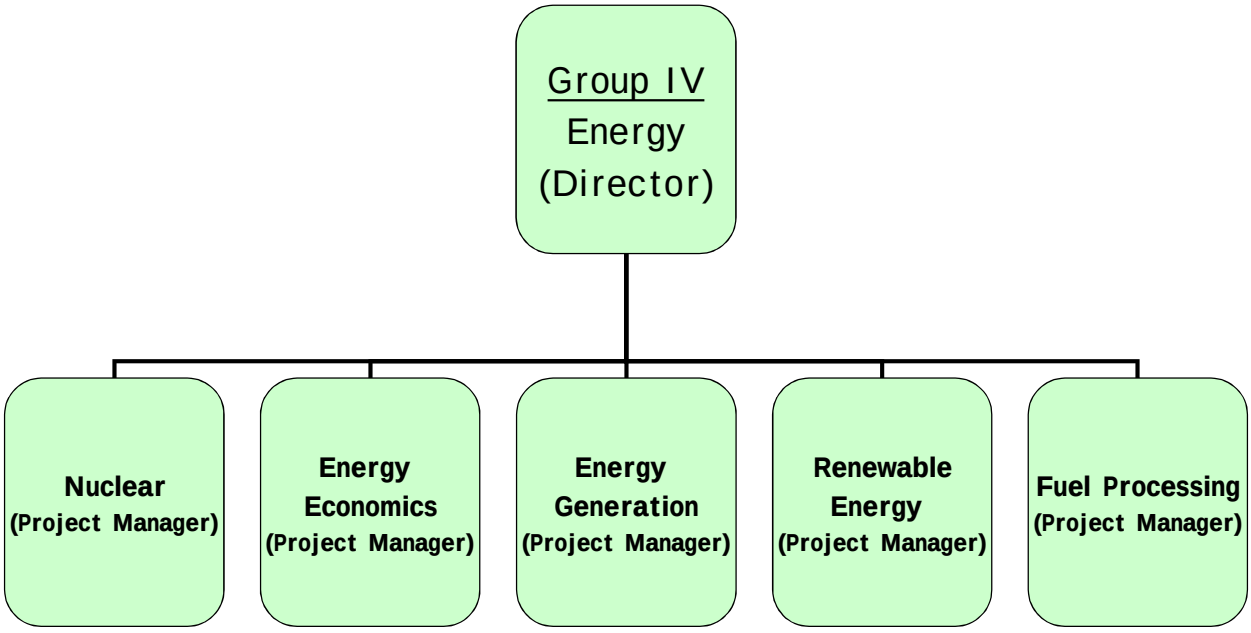

Figure 13. Transcending degree program: Programming Organizational Structure

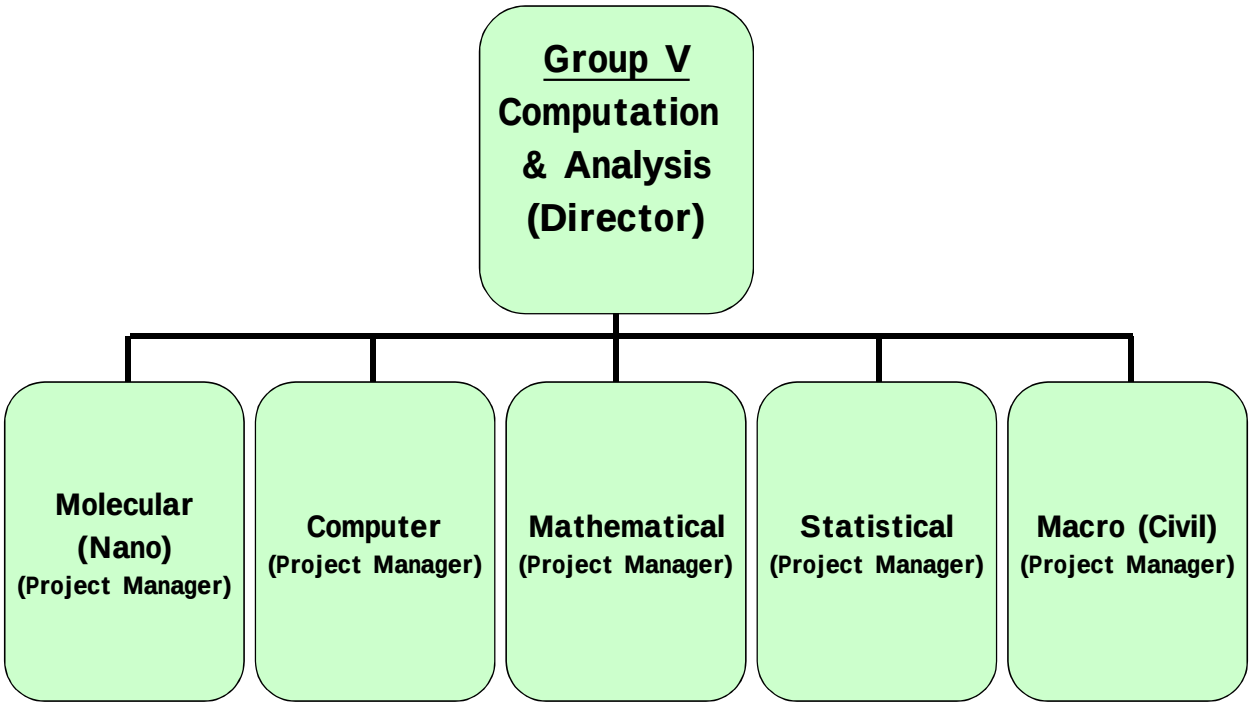

Figure 14. Transcending degree program: Programming Organizational Structure

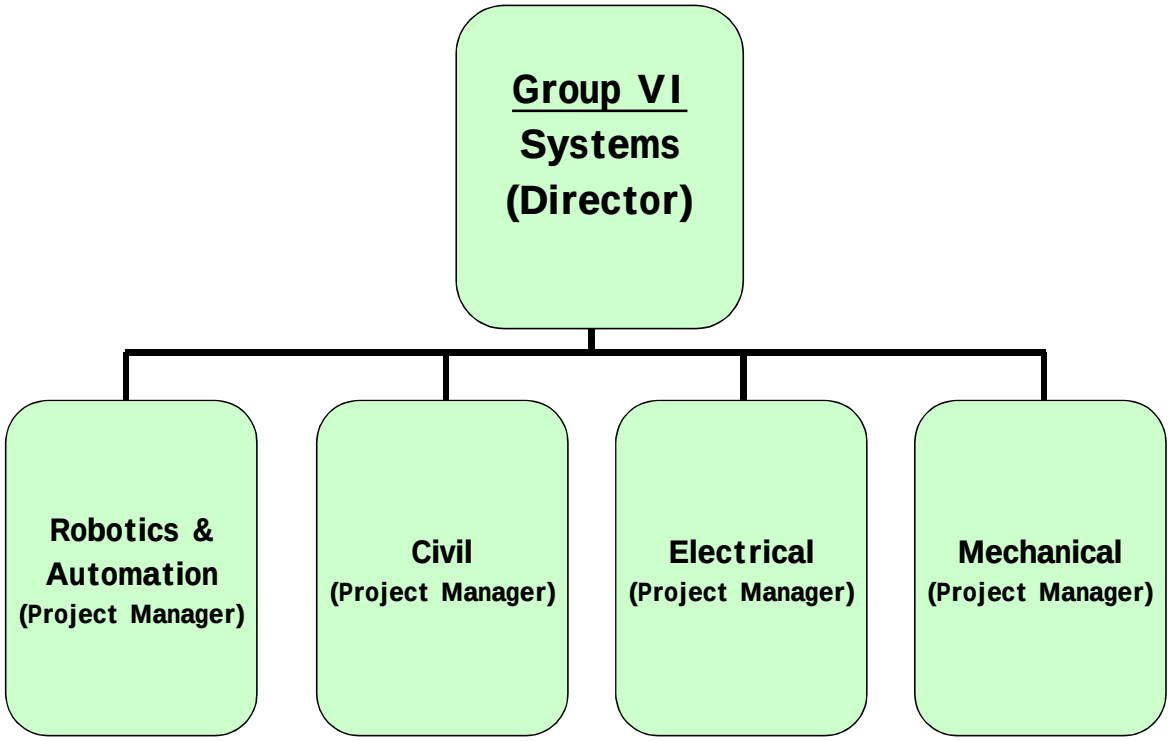

Figure 15. Transcending degree program: Programming Organizational Structure

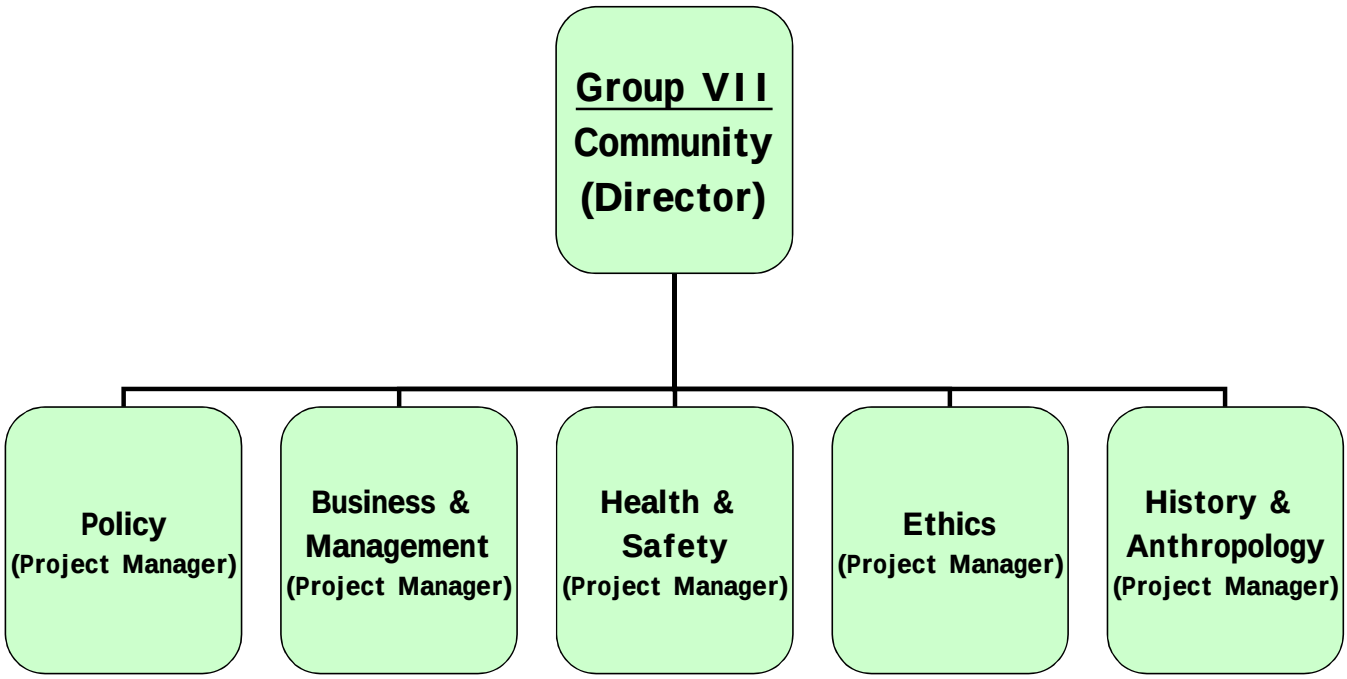

Figure 16. Transcending degree program: Programming Organizational Structure

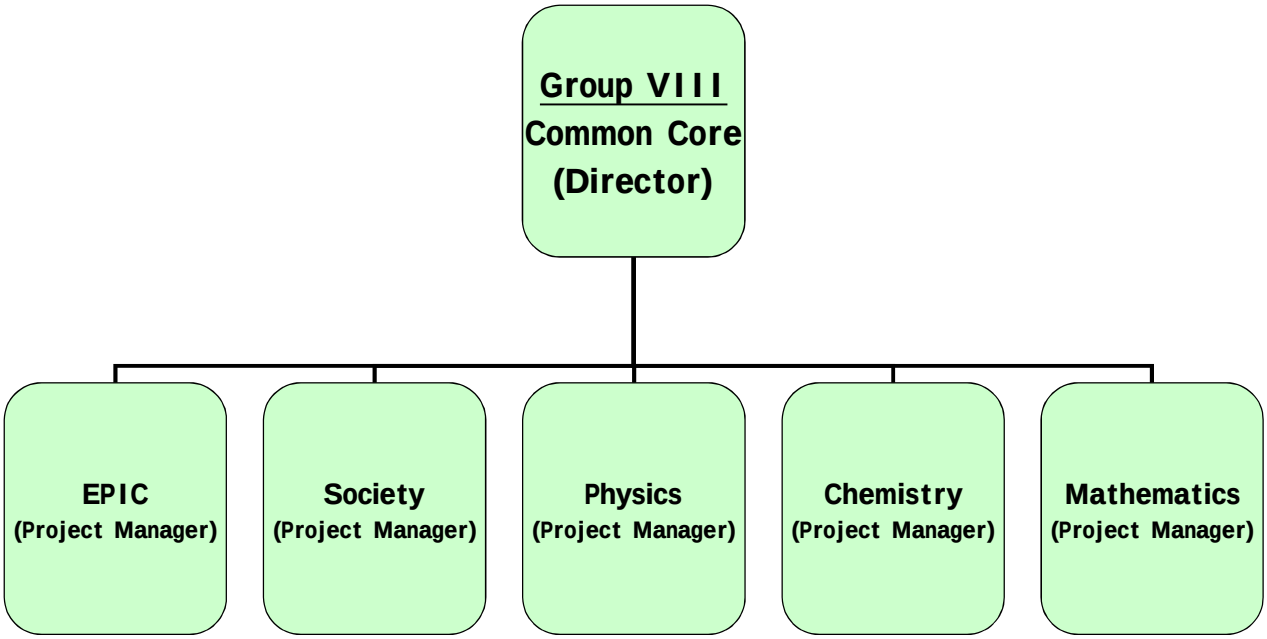

Figure 17. Transcending degree program: Programming Organizational Structure

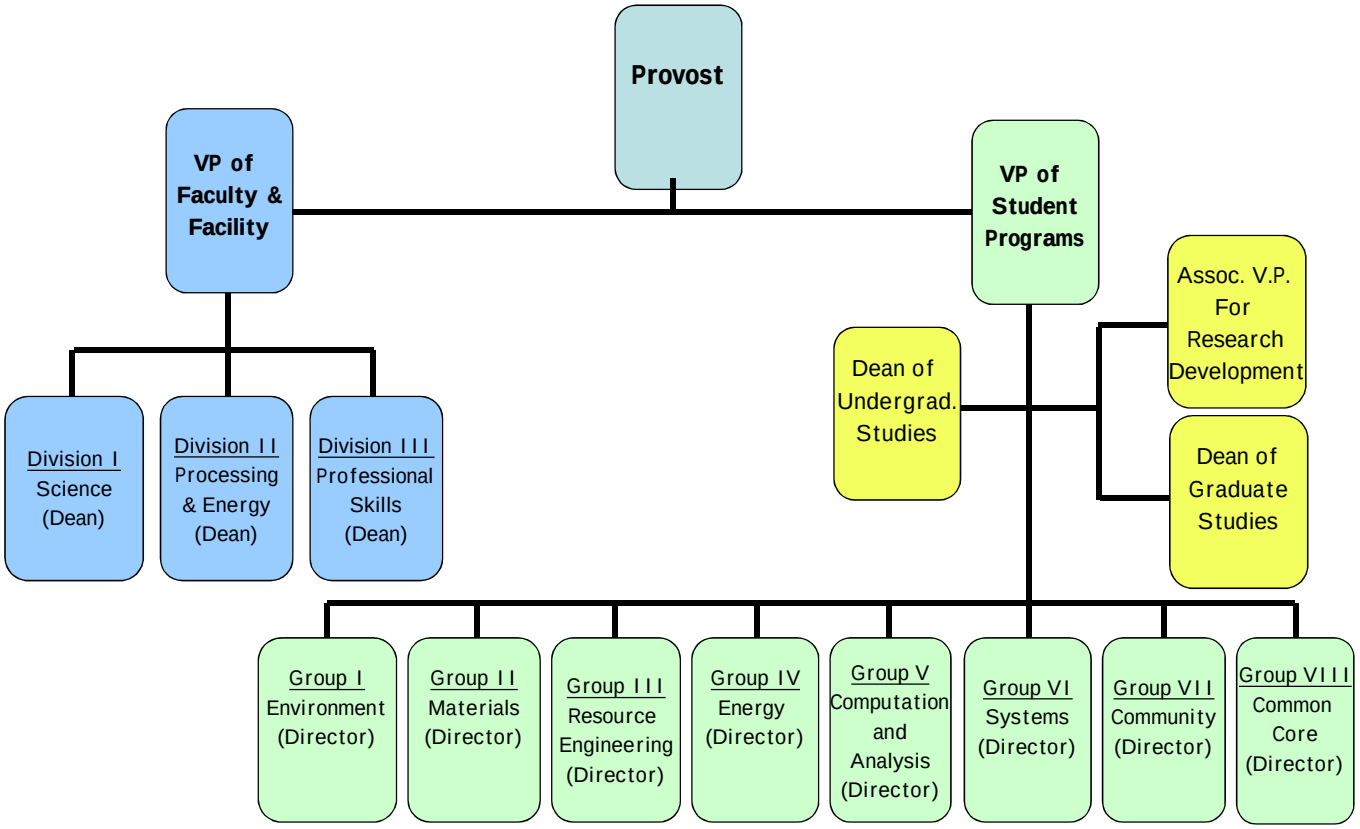

Figure 18. Transcending degree program: Organizational Structure

G. A Back of the Envelope Calculation

The demographics for Student-Program management involvement are given below. The partitioning of the number of students per program manager is shown to illustrate that this program will require approximately fifty teaching faculty to serve as Program Managers.

- 6000 Students
  - 5000 Undergraduate Students
  - 1000 Graduate Students
- Per Program Manager
  - Assume 50 Program Managers
    - ~100 Undergraduate Students
    - ~20 Graduate Students
    - ~120 Students / Program Manager
- **~30 New Undergraduates / Year / Program Manager**
- **~7 New Graduates / Year / Program Manager**

H. Institutional Advancement

(Solution to the difficulty with institutional investment)

The transcending engineering degree program requires high quality – and sometimes unique – courses, laboratories, special equipment and faculty to educate students to be prepared for a career at the interface between two disciplines. Many of the existing CSM degree programs already have an interdisciplinary appearance, such as

geo-chemistry, mineral economics and petroleum-refining, and presently are adequately equipped to prepare quality transcending degree products.

For example, however, new investments will be needed for biological preparation for students seeking a degree in biomaterials and an upgrade of the microelectronic laboratory would be needed for a microelectronics-manufacturing degree program. With a new institutional focus on identifiable interdisciplinary degree programs, even existing degree programs can be re-equipped and upgraded for a new institutional advancement effort.

A promotional drive by institutional development would be necessary to guarantee a meaningful and rewarding leading-edge education through this transcending degree program. However, the transcending degree program clarifies and focuses emphasis – it identifies a specific uniqueness for a donor's gift

The transcending degree initiative should be a door-opener to philanthropic individuals and corporate foundations that are always looking for new endeavors for excellence in engineering education and for programs that will become educational leaders. This transcending degree program can be marketed as a leading edge effort in the 21st century.

H. Writing the Research Roadmap

(Solution to need for proper phasing in investment for program enlightenment)

A small school program with program managers can organize an interdisciplinary response rapidly and initiate new, unique programs. These unique programs can

emphasize interdisciplinary uniqueness and qualities to promote programs in their departments. Interdisciplinary teams can shape unique roadmaps to put CSM at the leading edge of research.

V. Requirements for Implementation

In order to implement the transcending degree program, CSM will require a curriculum with a logical sequence of courses in two parallel study areas: one disciplinary and the other a transcending field of study. The undergraduate must have a planned set of courses, some of which must begin during the sophomore year. There would need to be additional quality advising for students. Faculty would need training for effective student advising. Faculty would also need clear guidance for formulating sabbaticals or other renewals.

Sufficient investment for new laboratories to support the new topic initiatives would be required. Also there would need for sufficient investment in expanded library acquisitions.

The Promise:

1. **For CSM to be a Leader in Interdisciplinary Engineering Education and Research**
2. **For CSM to offer Unique Programs and Experiences**

VI. Conclusions

Now is the time for CSM to take positive action. Presently, CSM is in danger of becoming an educational and research follower, out-of-phase with many new initiatives and maintaining a faculty who is not fiscally or culturally encouraged toward research innovation. Interwoven with these hindrances is the significant effort that is necessary to convince high-value donors and foundations to support our institution. Worse, as a result it could become difficult to attract the pioneering, high-caliber students that we wish to academically equip and nurture – those who will carry the world's engineering programs into the future.

For us to continue to maintain the important attribute of uniqueness, appealing to and attracting dynamic future students to CSM, we must clearly identify and broaden the application of our unique perspective, which has always been a Mines' strength. A transcending degree program would renovate and energize Mines' students and faculty, allowing us to broaden our scope and serve an extended added-value industry. The proposed transcending degree program can lead the way to better serving the student body with innovative programming and with faculty supported in their dedication to cutting-edge research. Here at Mines we will know we are in a position of excellence when our programs, our faculty, and our students are establishing the research roadmap. We must strive to be in this position and a transcending degree program can focus our travels.

"If you always do what you've always done,
then you'll always get what you've always gotten."
-Oliver Wendell Holmes

VII. Acknowledgements

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