# THE COLLEGE OF SCIENCES AND ARTS PORTFOLIO

February 2000

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DRAFT 2000

**College Portfolio**

This first version is based

- on departmental portfolios (which can be consulted for in-depth reading; web-addresses are given at the end)
- on the feedback to the College Outline received from the Strategic Planning Group and the Washington Advisory Group,
- on Anita Jones' Information Science, Engineering and Technology Report,
- on individual meetings with all department chairs of the College of Sciences and Arts,
- and on College Council meetings.

The College Portfolio was jointly produced by the College Council and has the endorsement of all department chairs.

Max Seel, Dean
Winter Carnival 2000

*This is the first draft for a College of Sciences and Arts Portfolio. It is based on portfolios prepared by departments which are by their very nature and role quite different. However, they agree on key features and key strategies. In its first form, the College portfolio tries to capture these key features and strategies and outlines a vision of the College of Sciences and Arts 10 years from now. It provides commentary on why these key features and strategies are considered to be essential. It is still short on quantitative metrics, targets, and time lines. It is input for a first iteration in an iterative process involving both the faculty and staff of the College on Sciences and Arts and the strategic planning group preparing the university plan. If agreement or consensus on the goals and strategies can be reached then the metrics and measurable targets will be sharpened.*

# 1. THE VISION

## 1.1. Mission

The College of Sciences and Arts provides the foundation, the fundamental principles, and the areas of creativity and enrichment which are at the core of all university learning. The College educates undergraduate and graduate students to have a global perspective and prepares them to reach their full potential in a technologically rich and ethnically diverse society.

## 1.2 Vision

The College of Sciences and Arts will be a college of choice nationally with exciting programs, scholarship, and research in the science and technology niche. It will be an integral part of a university which is ranked in the top research tier by the Carnegie foundation. The success of our students will always be the most important measure. To that end, faculty and students will learn together in nationally prominent undergraduate and graduate programs which blend teaching, research, and scholarship; anticipate critical emerging directions; and cross the disciplinary boundaries.

## 1.3 Key Features

In order to accomplish our vision, we need a plan that is informed by the following general, overarching themes:

**@ Science and Technology**

This century is characterized by the rapid translation of science into technology and by the almost instant practical application of a new discovery. Michigan Tech will be successful if it can transform its traditional narrow technological core competency into a science and technology competency. New high demand areas are in communications, computing and information technology, biotechnology, smart materials, environment and resource sustainability reflected by fast-growth industries in e-commerce, internet, web applications, micro- and nano-technology, industrial ecology and sustainability.

**@ Unique Characteristics**

Our programs and scholarship will be noted for their disciplinary and interdisciplinary strength. That is, we desire to move into cutting edge interdisciplinary relationships across the College and the University through our "Sci/Tech Plus" initiative (see below under strategy 1.3.1). At the same time, we recognize that strong interdisciplinary programs are contingent upon strong disciplinary foundations.

**@ Carnegie I**

Michigan Tech is at the threshold of moving from a regional university to that of a Research I university. Since reputation is based on scholarship and research, we will become a university of choice in science and technology only if this transition is achieved. Therefore, the College of Sciences and Arts supports this goal as being fundamental to the overall strategy.

**@Success of our Students**

The Carnegie I goal is mutually consistent with high-quality undergraduate education. Scholarship and education are inextricably linked. Knowledge is key. The education of leaders requires faculty who are leaders. The education of students to be innovative demands faculty who are innovative in teaching and research. The education of students to unleash their creativity needs faculty who are creative.

**@ Internet**

Our strategic plan needs to take into account the impact of the internet, web-based instruction, and for-profit education. The College must provide an education that prepares students for an internet-based economy and a networked world as well as for social interaction. The College needs to address where it sees its competitive niche in an environment where the e-commerce market tries to segregate "knowledge delivery", "knowledge creation", and the "social aspects" of a traditional college education.

**@ Globalization and Diversity**.

The explosion in global electronic communication and the removal of political obstacles for collaborative research and education has impacted every department in the College of Sciences and Arts. Modern research groups are truly global. We need to take advantage and incorporate this into a meaningful experience for our undergraduates: global interconnectedness of markets and economies demand educated persons who can function in a global and diverse environment.

**@ Art: A Counterpoint to the Science and Technology Focus**

Science and technology are not value-free. In an environment focused on science and technology, the College's programs in the arts -- for education, participation, and enrichment -- provide opportunities to nurture high values. "For art establishes the basic human truths which must serve as the touchstones of our judgement" (J.F. Kennedy).

## 2. STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS

### 2.1 Internal Strengths

Quality of faculty; quality of student body; science and technology niche; selected facilities; small enrollments in many junior and senior level courses and doctoral programs permitting close faculty-student interaction; potential to draw diverse gender and ethnic faculty and student body; rich environment for interdisciplinary work; location.

### 2.2 Internal Weaknesses

Low proportion of undergraduate majors in Sci&Arts; small alumni (and hence small donor) base and endowment; lack of diverse student and faculty body; small enrollments in many junior and senior level courses making course delivery expensive on a per student basis; small enrollments in doctoral programs; facilities.

### 2.3 External Opportunities

Enrollment growth in most majors; attract top transfer students into sciences and arts programs; science and technology key driving forces of the present and future; attractive niche for international students; internet.

### 2.4 External Threats

Engineering-school-only reputation impediment to recruitment; limited resource base and faculty lines; isolated geographic location; while MTU's tuition is low for an engineering school, it is not low for students who wish to study in traditional sciences and arts areas; funding base; internet; for-profit skills providers.

# 3. CURRENT STATUS AND GOALS

## 3.1 Current Status

**Profile:**

Sci&Arts majors = 21 % of total student body.
Overall College ratio between undergraduate/graduate: 84/16.
(note: some departments have no majors (Phys Ed; Fine Arts; ROTC)
one has secondary education certificate (Education)
some have majors and MS programs (CS, Social Sciences)
some have majors, MS and PhD programs (Bio, Chem, HU, Math, Phys)
The 5 PhD programs + 1 interdepartmental/college PhD program currently yield ~23 PhD/year.

| **Department** 1999-2000 data | UG | MS | PhD | Faculty (t-t)*) | Staff | General Fund (1999-2000) (In 1000) | Research Expenditures (FY99, in 1000) | SCH All Faculty (1997-98) |
|---|---|---|---|---|---|---|---|---|
| **Biology** | 231 | 14 | 21 | 13 | 6.5 | 1,122 | 1,066 | 8,384 |
| Clinical Lab Sciences | 44 | | | | | | | |
| **Chemistry** | 56 | 8 | 25 | 18 | 12 | 1,578 | 314 | 20,478 |
| **Computer Science** | 422 | 37 | **) | 12 | 2 | 973 | 416 | 9,876 |
| General Studies | 6 | | | | | | | |
| **Education** | | | | 3 | 1 | 273 | | 3,068 |
| **Fine Arts** | | | | 9 | 4 | 553 | | 3,876 |
| **Humanities** | 133 | 17 | 35 | 30 | 7.75 | 1,937 | 10 | 23,406 |
| **Mathematics** | 67 | 8 | 11 | 28 | 3 | 2,091 | 103 | 35,355 |
| **Physical Education** | | | | 1 | 3 | 249 | | 5,599 |
| **Physics** | 56 | 1 | 22 | 19 | 7 | 1,383 | 1,063 | 12,919 |
| **Social Sciences** | 41 | 18 | | 17 | 4.25 | 1,025 | 116 | 14,539 |
| Undeclared | 71 | | | | | | | |
| NonDegree Seeking | 134 | | | | | | | |
| **College Total** | **1,261** | **103** | **114** | **150** | **50.5** | **11,183** | **3,088** | **138,559** |

*) These are October 1, 1999 payroll data. They do not necessarily equate actual faculty numbers. For example, Mathematics has 31, not 28 faculty, Chemistry has 19, not 18.
**) CS enrolls 6 PhD students in the Computational Science and Engineering program.

The College has the "right" mix of majors in current high-demand areas: 33% in Computer Science, 22% in Biology , and 10% in Technical Communication. This provides a good base to grow in the information and biotechnology areas.

The College is in the process of preparing and updating faculty and program profiles. Departmental details will be available for analysis, assessment, and comparison. The following quantitative and qualitative performance indicators are currently under consideration:

**Quantitative Productivity Factors**

| | College | University | % | per t-t faculty S&A |
|---|---|---|---|---|
| **Ranked Faculty (t-t)**: | 151 | 344 | 44 | |
| Credit Hours (**fiscal 98/99**): | 4,461.5 | 11,067.5 | 40 | 29.5 |
| SCH: | 83,810 | 176,093 | 48 | 555 |
| Weighted SCH: | 135,166 | 316,744 | 43 | 895 |
| **All Faculty**: | | | | |
| Credit Hours | 7,029.8 | 14,912.6 | 47 | |
| SCH: | 145,146 | 263,051 | 55 | |
| Weighted SCH: | 212,686 | 436,082 | 48 | |
| **Bachelors Degrees**: | 188 | (**1997-98**) | | 1.25 |
| **MS Degrees**: | 41 | | | 0.27 |
| **PhD Degrees**: | 20 | | | 0.13 |
| **Research $**: | $3 million | | | $20,000*) |

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*) Due to the distinctly different nature of the sciences and arts programs, this is not a very meaningful number on a college-wide basis. It makes more sense to define a "per science faculty" base (see table on preceding page)

**Quality Measures**

**Publications**: 358 2.37

**Other measures** (in progress): Offices held in national professional societies, NSF career awards, prizes for scholarship/pedagogy from professional societies, editorial board memberships.

**Other Visibility Factors and Special Areas with National Recognition**

Numbers and numerical measures alone don't tell the whole story. Various departments within the College have exploited opportunities to establish national recognition in selected niches and these provide areas of basic strength on which we can build.

Biology faculty contributed to the establishment of Michigan Tech's tree biotechnology program, is engaged in cutting edge research in ore extraction through bacteria, and in multi-departmental environmental research. Biology also places 70% of applicants into medical schools (national average 38%). Chemistry faculty are known for the development and testing of new polymers for high-tech applications, lead a large-scale integrated scientific study of the Lake Superior ecosystem, and have an international reputation in the area of optical probes of chiral molecular and biomolecular structure. Computer Science conducts nationally recognized research in compilers - as demonstrated by federal funding and support by multiple industry partners (TI, HP, Compaq) - and in high-performance, parallel, and distributed computing. The Humanities department competes consistently with the best programs in the country - RPI, Purdue, Ohio State, Carnegie Mellon, Penn State - as one of the leading programs in technical communication, both on the undergraduate and graduate level. It produces and edits four international journals. Its Center for Computer-Assisted Language Instruction is nationally recognized as one of the oldest and consistently cutting edge centers for the use of electronic technology in educational environments. The department of Mathematical Sciences has assembled an internationally known group in discrete mathematics. At the same time, its faculty has received repeatedly state-wide recognition for its excellence in teaching. Physics faculty have leadership roles in the Pierre Auger Observatory (the world's largest cosmic ray observatory), the Astronomy Picture of the Day (25 million page hits per year), and in the design of instruments for major international collaborations as well as spacecraft payloads. The department of Social Sciences is considered the primary center for the graduate study of the sub-discipline of industrial archaeology in the US. It serves as the national headquarters for the Society of Industrial Archaeology and edits its journal.

Some of these examples rest heavily on a specific faculty member. We need to develop programs that are sustainable independent of individuals.

### 3.2 The Goal

The College pursues ONE GOAL:

**To develop and sustain nationally recognized undergraduate and graduate programs in MTU's science and technology niche.**

To achieve this goal requires FOCUS. The College distinguishes itself in two fundamental ways from the arts and sciences colleges at other institutions. First, we focus our curriculum, scholarship, and research on a technology and science niche that drives the content and the spirit of the College. Second, we weave our diverse disciplinary interests and strengths through this technology and science focus to create unique, innovative interdisciplinary programs that continually explore and, ultimately, expand the boundaries of learning for both students and faculty.

To build strong interdisciplinary programs requires a strong disciplinary core. Currently, the College of Sciences and Arts provides the essential core in mathematics, the sciences, the social sciences, the humanities, and the arts. While assessment might provide indication of relative under- or over-performance of individual programs, and, therefore, suggest some reallocation of resources, downsizing or elimination will not provide a major source of new resources. We already provide a smaller number of degree offerings than any other college in Michigan and, as a university, have the bare minimum number of PhD programs to qualify for Carnegie I.

The size of most of the disciplinary departments places limits on their ability to secure broad-based national recognition, i.e., recognition for the unit as opposed to outstanding individuals within the unit. Thus, meeting the goal of national recognition will require identifying and promoting programs that cross disciplines, drawing on strength of multiple departments in new ways.

## 4. THE 2000 - 2010 PLAN

### A. STRATEGIES

**Strategy 1. Develop nationally recognized degree programs**

**Strategy 1.1. Continue to provide the foundation, the fundamental principles, and the areas of creativity and enrichment which are at the core of all university learning**.

A strong foundation in the sciences and arts is central to every professional degree offered at Michigan Tech. This is independent of whether the degree is in mining or in bioinformatics.

The "traditional" general education areas including not only the Fine Arts, Social Sciences, and the Humanities, but also the mathematics and the sciences are clearly **areas we must have**.

Physical education and intramural programs will continue to provide a comprehensive package of opportunities for participation in sports activities and wellness concepts for students, faculty, and staff.

**Strategy 1.2. Be a recognized innovator in the effective and appropriate application of technology in undergraduate instruction.**

The College of Sciences and Arts will provide students access to modern educational technology. The College will continue its tradition of effective and caring instruction based on personal contact by dynamic educators. However, the classroom setting will be constantly changing as faculty develop and implement new teaching strategies and new technologies aimed at providing a world-class environment for the success of all learning styles.

**Areas to be de-emphasized**: Always looking to the future, but continually aware of the past, we recognize the need to find a balance between the desire to produce web-based instruction and to maintain the personal contact with students that is so vital to a broad-based educational experience. Thus, we will continually reexamine our areas of emphasis related to web-based curricula to insure that we do not lose the intimate social experience we feel is key to our College's well being.

**Strategy 1.3. Focus on programs with national recognition and in areas of critical need**

UNDERGRADUATE PROGRAMS

**Areas we must have**: The role that Michigan Tech plays in the economic health of the State of Michigan requires that we continue to provide highly qualified graduates in "traditional" disciplines. The state will need for the foreseeable future broadly educated biologists, chemists, computers scientists, mathematicians, physicists, etc. to assume the variety of roles required in a wide variety of research and production laboratories. However, major growth areas are to be expected not so much in disciplinary majors, but in interdisciplinary degree options since much of the excitement in science and technology and many of the new industries will be at the interface of the traditional disciplines. That is, the **areas with a strong base that need to be expanded** are in emerging areas of science and technology that are interdisciplinary.

**Strategy 1.3.1. Launch several cutting-edge interdisciplinary undergraduate programs under the Sci/Tech Plus umbrella**

Under the "Sci/Tech Plus" umbrella program we will launch new degree programs which represent a combination of two or more disciplines, most commonly computing plus a second discipline, biology plus a second discipline, or communication plus a second discipline. This will lead to highly attractive degrees in the information technology, biotechnology, and communications arenas. Three examples follow:

**Cheminformatics**

The department of Chemistry in collaboration with the Department of Computer Science will initiate a new B.S. degree program in Cheminformatics. This degree is at the true interface of these two disciplines, and will prepare students with the skills necessary to be able to interpret results from combinatorial chemistry, computer modeling, and other techniques, and integrate these results into modern scientific databases for far-reaching applications in the pharmaceutical and chemical industries.

**Bioinformatics**

Launch a B.S. degree in Bioinformatics that will integrate strength in the biological analytical sciences (biochemistry and molecular biology) with strong computational science expertise

**Communications Tech Plus**

Similarly, initiate a program that prepares students to work with communication technology within a particular professional context of their choosing. Requires the equivalent of a major in Humanities (30+ course hours) and a "strong minor" in a second discipline outside the Humanities (20+ hours; in science, engineering, computing, business, the arts, the social sciences)**.**

**Computer Engineering,** a more traditional program between two disciplines, which has been introduced recently, needs to be reexamined (see Anita Jones report). **Software Engineering** can be introduced relatively easy by Computer Science. Note that the new options in the area of computing and information technology rely to a great extent on **discrete mathematics.** Our strength in this area provides strong support for these curricular options.

**Strategy 1.3.2. Provide a model secondary teacher education program**

The quality of schooling in America has been judged to be inadequate for the current times. Strengthening the way universities prepare teachers has become a key element on both national and Michigan presidential agendas with major funding opportunities. 2 million new teachers will be needed. Michigan Tech already has a strong foundation in the area of mathematics and science secondary teacher education (8-12), with new options in Social Studies and English which have become highly successful due to a "technology-rich" curriculum. While nationally 40% of math/science teachers do not hold a major/minor in the discipline they are teaching, at Michigan Tech teacher candidates are required to major or minor in the disciplines they will teach. The integration of the education department into the College of Sciences and Arts puts us on the cutting edge. New options with technology and forestry will be proposed. To make the new options successful, some additional support to teach the necessary methods courses is required.

**Areas with no current base that ought to be started**:

There are no resources to start something brand-new.

**Areas to be de-emphasized**:

As pointed out before, the College of Sciences and Arts provides the essential core in mathematics, the sciences, the social sciences, the humanities, and the arts. This needs to be maintained. In order to accommodate the anticipated new interdisciplinary programs, smaller growth in traditional sciences and arts majors and a smaller number of traditional engineering majors is expected.

Replacement faculty positions in departments will be filled if they are necessary to maintain the critical core disciplinary knowledge and/or to support the interdisciplinary growth areas identified above. New faculty lines will follow the same principle.

GRADUATE PROGRAMS

Growth in research and research funding requires growth of graduate programs. We don't have PhD programs to eliminate - university-wide there are only 15. With limited resources, the introduction of new PhD programs needs to be carefully analyzed. Two new programs are proposed. It will be essential for all programs that the university is competitive in the areas of graduate student stipends, health insurance and workload.

**Strategy 1.3.3. Create a Computer Science PhD program**

The CS department has a growing research program, but its research productivity is, or will be, severely hampered by not having a PhD program. Research projects are best accomplished when graduate students stay with a project for some years. Currently, the CS department is using the Computational Science and Engineering program for a few select students. It is time to create a CS PhD program.

**Strategy 1.3.4. Create a PhD program in Applied Engineering Physics**

Taking advantage of overlapping research areas and faculty appointments, especially in materials and electronics/ instrumentation, a new PhD program in Applied Engineering Physics offers exceptional institution-wide prospects. It supports a vision of Michigan Tech being nationally recognized for its science and technology competency and rapid translation of science into technology.

**Strategy 1.4. Strengthen the international aspects of our programs for a diverse community**

Many individual departmental resources, programs, and initiatives promote international communication and provide an international learning experience, e.g., the Humanities' modern languages programs, the College's efforts to implement and improve "World Cultures" courses, international performance tours, international scientific exchange. One innovative initiative is highlighted because it benefits both international graduate and US undergraduate students from departments and colleges across the university. The College is committed to strengthening the university's commitment to international students through expansion of the Humanities GTA preparation program which currently provides instruction for international GTAs: drawing on the experience and pedagogy gained in the Writing Center and by partnering US undergraduates with foreign graduate students, graduate students become immersed in the US culture and undergraduates become acquainted with world culture. Consistent with the expectation that the university's graduate programs will grow, this program needs to grow to accommodate 150 international graduate students by 2003.

**Departmental diversity plans**: Departments developed in their individual departmental plans specific initiatives which reflect the need to have a faculty and student body representative of an increasingly diverse world.

**Strategy 1.5. Make art a counterpoint to the science and technology focus**

In the age of "internet speed" and "connectivity" where time and space shrink with the advent of the web, beepers, and desktop video-conferencing, we are in danger of losing touch with the importance of human interaction and basic human truths. We believe it is important and a competitive advantage in the for-profit education market that Michigan Tech provides the sense of community, family, and enriching experiences that encompasses a truly well-rounded and well-founded education. The College's programs in the arts -- for education, participation, and enrichment -- provide opportunities to nurture these values.

The completion of the Rozsa Performing Arts Center will provide the university and the community with an acoustically superb and visually beautiful facility in which to experience, perform, and learn about the arts. It will elevate the quality of the College's music, theatre, and visual arts programs through its performance and exhibit spaces and its specialized rehearsal, recording and computer labs.

**Strategy 2. Develop nationally recognized research thrusts, centers, and institutes**

National recognition and reputation is based on scholarship and research. The size of most departments limits their ability to achieve high national rankings. Therefore, the goal of reaching national prominence can best be achieved by selecting and promoting a **few strategic research areas** which are supported **university-wide**.

**Strategy 2.1 Identify and align with the university-wide strategic research areas**.

A matrix structure will be useful to identify how the departments of the College of Sciences and Arts can contribute to strategic research areas. The university-wide discussion on **Areas we must have**, **Areas with a good base that must be expanded**, **New Areas, Areas to be de-emphasized**, will identify the **research foci**. Areas which have been mentioned are: Environment, Materials, Manufacturing, Biotechnology, and Information Technology. The following matrix shows the expertise of Sciences and Arts departments in these research areas.

## Matrix of strategic research areas

| | Biotech | InfoTech | Environment | Manufacturing | Materials | Disciplinary Core Knowledge/Expertise |
|---|---|---|---|---|---|---|
| **Bio** | Molecular Biology<br>Biochemistry | Generation of Biostructural Info | Ecological Research<br>Aquatic/terrestrial Interactions | | Automated Bioreactor | e.g. Botany, Physiology<br>Biochemistry |
| **Chem** | Bio-organic Chem.<br>Biomolecular modeling<br>Biosensors | Computational Chem. | Environ. Photochem.<br>Environ. Analysis | Polymer Chem.<br>Catalysis | Polymer thermosets | NMR<br>Spectroscopy<br>X-ray diffraction<br>Organic synthesis |
| **CS** | Artificial Intelligence, parallel computation, high performance computing, software engineering, visualization, graphics and geometric computing can contribute to all 5 areas | | | | | |
| **HU** | Medical communication | Computer User Documentation<br>Media design<br>Usability testing | Risk communication<br>Public information | | | e.g.,Ethics, Philosophy<br>Basic General Education<br>Scientific and technical Communication |
| **Math** | DNA mappings<br>Simulation tools | Design Theory<br>Coding Theory<br>Optical Codes | Statistics (contributes to all 5 areas) | Rheological Flow Instabilities<br>Combustion simulation | Modeling composites | Discrete Math<br>Applied Math<br>Statistics |
| **Phys** | Biomodeling<br>Laser neuron guidance | Computational Quantum/ Statistical Physics | Atmospheric Physics<br>Hyperspectral Imaging<br>Remote Sensing<br>Image Processing | Nanomanufacturing<br>Laser particle guidance<br>Surface Physics | NMR/NQR<br>Comp. Modeling<br>Ferroelectric/Magnetic materials | e.g. Astro, Atomic, Statistical, Computational physics |
| **SS** | | | Environmental Policy | | | Industrial history<br>General Education |

**Strategy 2.2. Develop off-campus partnerships with other universities, federal laboratories, and industry**

Individual departmental plans specify specific plans and partnerships. We will establish 1-2 new corporate research (educational) partnerships at the level of $100,000 each year for the next three years**.** One general area which needs to be improved is the use and marketing of **intellectual property**. For example, the paperwork required for one to accept small amounts (<$10k) of industrial support for short-term seed projects should be reduced or eliminated. The **patent royalty policy** also needs to change. Currently, colleges receive no return on royalty revenues, yet deans are often asked to share financial support for projects in the initial phase. Departments share only 1/3 of the revenues generated up to $180,000. The royalty sharing agreement should be amended so that a portion of the university's share above $180,000 is distributed to the appropriate departments and colleges.

**Strategy 3. Provide a strong financial base**

The College supports a university budget model that combines positive feedback, internal quantitative productivity measures, quality measures, and benchmarking. The model should be informative and allow for adjustments based on unit reviews and strategic planning. It needs to be transparent enough so that college budget allocation to departments can be rationalized. It should reward performance, quality, and progress towards goals. Benchmarking will allow comparing departments with their peers. Most of the points addressed below need further university-wide discussion before college-specific targets can be specified more precisely.

The state operating funding has been more or less steady. It is the largest segment of the **General Fund** revenue, but its share is declining. It is unrealistic to expect a significant increase to support the increase in resources necessary to achieve the goals described above.

**Research funding**, particularly that generated from external sources, is an important component of the University budget. While the amounts and sources of funding vary widely according to discipline, we anticipate that overall growth of external grants and contracts will average 10% -15% per year.

In order to reach Research I status, grant proposals need to emphasize PhD graduate student support. The percentage of externally supported graduate students must increase (see benchmark data below). In order to grow our research enterprise, we should consider increasing the number of **research faculty**. The position needs to be an attractive alternative to a regular tenure-track appointment, with health benefits, bridge funding if their funding temporarily slips while proposals are being reviewed, and attractive salary options. To reach the specific goals outlined in the departmental plans, research faculty needs to make up approximately10% of total faculty. Several departments have specific departmental plans to **expand corporate partnerships**,

**Private funding** is anticipated to grow. As a result of Michigan Tech's first capital campaign, we anticipate **growth in scholarships and tuition support** to ease the pressure on the general fund,

**matching funds for a building** without which the necessary expansion in information technology and growth in research will not be possible, and **endowed chairs** in many departments.

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**Benchmark Data for full-time graduate science and engineering students, by source of support:**

| | MTU | RPI | Georgia Tech | Michigan State |
|---|---|---|---|---|
| Federal support | 112 | 218 | 784 | 545 |
| Institutional support | 316(58 %) | 389(34 %) | 917(34 %) | 1,422(55 %) |
| Other outside support | 30 | 165 | 483 | 301 |
| Self Support | 83 | 375 | 507 | 311 |
| Total | 541 | 1,147 | 2,691 | 2,579 |
| [Teaching assistantships total | 150(28 %) | 280(24%) | 407(15%) | 822(32%)] |
| [Institutionally supported | 147 | 277 | 387 | 802 ] |

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## B. TIMELINE, RESOURCE ALLOCATION, MEASURABLE OUTCOMES

In the next iteration, the college portfolio needs to fully articulate timing, targets, and resource allocations to make the plan succeed. Currently, best estimates are offered for discussion and to invite feedback from faculty and staff of the College of Sciences and Arts and from the University strategic planning group. The summary table below presents these estimates. The underlying targets (and assumptions) are:

By 2010, the College of Sciences and Arts should accommodates **400 more undergraduate students for a total of 1650.** Many of these new students will probably be in new programs like Cheminformatics or Bioinformatics. These options should be available by 2000 to 2002. Students in these programs are listed under “SciTech Plus”. Fast growth in these interdisciplinary areas will probably lead to some reshuffling in traditional majors. **PhD students will** almost **double** from currently 114 to **215**, with a small increase in **MS students** from 103 to **140** (82/18 undergraduate/graduate ratio).

Undergraduate majors to faculty ratio is one quality factor. To bring the current ratio of 40:1 in Computer Science to 20:1 would require 10 new faculty. At the same time, any absolute increase in undergraduate majors (except transfer students) increases the service load of all departments in Sciences and Arts.

Additional faculty lines are necessary to cover the additional service load and to reach the goal of doubling the number of PhD students and raising **research expenditures** from currently $3 million to **$10 million annually**. For the sciences, we propose a “challenge faculty line”: 2 new research faculty will be matched by 1 new tenure track line. We estimated, that **10 - 15 new tenure track faculty** lines (in addition to the **10 new CS faculty**) and **20 research faculty** are necessary to reach the targets given below.

Fisher Hall is at capacity. Faculty from computer science and physics already had to be moved to other buildings. The projected growth depends crucially on the State of Michigan funding the **Center for Integrated Learning and Information Technology as next capital project**. The university must also recognize that many of the older teaching and research laboratories are deteriorating, and the necessary funds to maintain or renovate the existing university physical plant must be secured.

**Estimated Profile of the College of Sciences and Arts in 2010:**

| Department | UG | MS | PhD | tt Fac | new ResFac | Res$(x1,000) |
|---|---|---|---|---|---|---|
| **Biology** | 350 | 20 | 25 | 15 | 4 | 1,500 |
| **Chemistry** | 100 | 15 | 45 | 20 | 2 | 1,000 |
| **CS** | 500 | 40 | 30 | 20 | 10 | 2,500 |
| **Edu** | | | | 5 | | 500 |
| **FA** | 20 | | | 10 | | |
| **HU** | 150 | 20 | 50 | 32 | | 100 |
| **Math** | 100 | 20 | 20 | 32 | | 1,000 |
| **Phys Ed** | | | | 2 | | |
| **Physics** | 100 | | 45 | 22 | 6 | 4,000 |
| **SS** | 100 | 25 | | 18 | | 200 |
| **Sci/Tech Plus** | 230 | | | | | |
| **College Total** | **1650** | **140** | **215** | **176** | **22** | **10,800** |

## C. BENCHMARKS

Benchmark data are currently collected. NSF's WebCASPAR database ( http://caspar.nsf.gov/ ) provides access to a large body of statistical data resources dealing with science and engineering (S&E) at U.S. academic institutions and is being utilized..

It is impossible to identify a single *college* benchmark. Possible departmental benchmarks include (RPI emerged with the broadest base): Rensselaer Polytechnic Institute, University of Missouri Rolla, Colorado School of Mines; California Polytechnic State University, Carnegie Mellon, Clarkson University, Georgia Institute of Technology, Lehigh University.

Other possibilities are Case Western Reserve, University of Illinois, Purdue, New Jersey Institute of Technology, U. of Virginia, Cornell, Iowa State, U. of Minnesota, Texas Tech, and New Mexico State.

### 4.D Partners in Change

The College's ambitious goals reflect a vision for Michigan Tech in which we will develop and sustain nationally recognized undergraduate and graduate programs in our science and technology niches. Success in reaching these goals is based not only on the success of our own efforts within the College, but also on our success in forging and sustaining critical cross-institutional linkages. These cross-institutional, trans-portfolio links and planning iterations include recruiting and retention at all levels (undergraduate, graduate, faculty), our contributions to the success of the Capital Campaign, new strategies of Intellectual Property management and research support development, partnerships concerning infrastructure development, and alignment with broad institutional activities such as the proposed Technology Park. Indeed, success in becoming one of our nation's premier technological institutions within the top tier of research institutions will require not just the best efforts of MTU's individual units, but a coordinated strategy that combines all aspects of the university, our vision and accomplishments, our excellent faculty and students, and our resolve to succeed.

## APPENDIX: Links to Departmental Portfolios

Biology: http://www.cec.mtu.edu/csa/portfolios/bio.PDF

Chemistry:
http://www.chem.mtu.edu/chemistry/PAGES/DEPARTMENT/STRATEGICPLAN/homepage.htm

Computer Science: http://www.cs.mtu.edu/cshome/html/administration/portfolio/portfolio.html

Education: http://www.cec.mtu.edu/csa/portfolios/edu.PDF

Fine Arts: http://www.fa.mtu.edu/strplan.html

Humanities: http://www.cec.mtu.edu/csa/portfolios/hu.PDF

Mathematics: http://www.math.mtu.edu/~jfretlan/StrategicPlan.html

Physics: http://www.cec.mtu.edu/csa/portfolios/phys.PDF
http://www.phy.mtu.edu/portfolio/strategic_planning1999.html

Physical Education: http://www.cec.mtu.edu/csa/portfolios/physed.PDF

Social Sciences: http://www.cec.mtu.edu/csa/portfolios/ss.PDF

Army ROTC:

AirForce ROTC: