Isssue of concern:
Some students have chosen a co-advisor from outside their administrative home department and that person has been the only external member on the committee. Question: Are all the roles of an external member well met by the co-advisor serving in that capacity? A subcommittee of GFC recommends that departments be given the flexibility to allow this but in recognition of the issue recommends the following additional statements (in bold) be added to the current policy language:

Changes are shown below for the Degree Requirements area of the web pages for the Doctor of Philosophy and Master of Science areas. Text equivalent to the text for the Master of Science area will appear in the MBA, Master of Forestry, and Master of Engineering areas.

Proposed Wording – for Degree Requirements - Doctor of Philosophy:

**ADVISOR**
…The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school. While one co-advisor may be from outside the student’s administrative home department, it is recommended but not required that this co-advisor not fill the role of sole external member on the student’s committee. Before recommending a sole advisor who holds an adjunct appointment in the student’s administrative home department, the appropriate graduate program director should ensure that this person is sufficiently familiar with the department/school standards for research and with applicable university policies/procedures and that this person can maintain adequate contact with the student.
…

**ADVISORY COMMITTEE:**
…This committee, with the addition of a fourth, external member, will often become the Examining Committee. If co-advisors are chosen and one co-advisor is from outside the student’s home department, it is recommended but not required that an additional external member must be chosen.
…

**ORAL EXAMINATION**
…The examining committee will be appointed by the Graduate School in consultation with the department chair. The committee will consist of at least four members of the graduate faculty. At least one of these will be from outside the student's administrative home department or school. The primary advisor, or a co-advisor who serves as chair of the committee, must be from the student's home department or school. While one co-advisor may be from outside the student’s administrative home department, it is recommended but not required that this co-advisor not fill the role of sole external member on the student’s committee.
…
Current Wording found in Degree Requirements - Doctor of Philosophy:

ADVISOR:
Initially the advisor may be the graduate program director, but as soon as possible, and no later than the end of the second semester in residence, a permanent advisor should be chosen. This Michigan Tech graduate faculty member advises the student on course selection and, if applicable, supervises the research experience. The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school. The advisor is an important factor in the graduate student’s timely and successful completion of the program of study. All graduate students must have an advisor.

ADVISORY COMMITTEE:
The advisor and committee, consisting of at least two members of the graduate faculty in addition to the advisor, will be recommended by the advisor and the chair/graduate program director of the major department, school, or program and approved by the Graduate School and filed on the Advisor and Committee Recommendation form. This committee, with the addition of a fourth, external member, will often become the Examining Committee (see “Oral Examination” below).

ORAL EXAMINATION
…The examining committee will be appointed by the Graduate School in consultation with the department chair. The committee will consist of at least four members of the graduate faculty. At least one of these will be from outside the student's administrative home department or school. The primary advisor, or a co-advisor who serves as chair of the committee, must be from the student's home department or school. For interdisciplinary and non-departmental programs, the outside examiner may not be affiliated with the interdisciplinary or non-departmental program. A person external to Michigan Tech may be appointed as an ad hoc member of the Graduate Faculty to serve as the outside examiner. Persons who are not members of the Graduate Faculty may not serve as voting members of doctoral examination committees.

…
Proposed Wording – for Degree Requirements – Master of Science:

ADVISOR

…The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school. While one co-advisor may be from outside the student’s administrative home department, it is recommended but not required that this co-advisor not fill the role of sole external member on the student’s committee. Before recommending a sole advisor who holds an adjunct appointment in the student’s administrative home department, the appropriate graduate program director should ensure that this person is sufficiently familiar with the department/school standards for research and with applicable university policies/procedures and that this person can maintain adequate contact with the student.

Examination Committee—The examination committee will be appointed by the Graduate School in consultation with the department chair. The committee will consist of at least three members of the graduate faculty. At least one of these will be from outside the student's administrative home department or school. The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school. While one co-advisor may be from outside the student’s administrative home department, it is recommended but not required that this co-advisor not fill the role of sole external member on the student’s committee.

Current Wording found in Degree Requirements - Master of Science:

ADVISOR:
Initially the advisor may be the graduate program director, but as soon as possible, and no later than the end of the second semester in residence, a permanent advisor should be chosen. This Michigan Tech graduate faculty member advises the student on course selection and, if applicable, supervises the research experience. The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school. The advisor is an important factor in the graduate student’s timely and successful completion of the program of study. All graduate students must have an advisor.

Examination Committee—The examination committee will be appointed by the dean of the Graduate School in consultation with the department chair. The committee will consist of at least three members of the graduate faculty. At least one of these will be from outside the student's administrative home department or school. The primary advisor, or a co-advisor must hold a regular or adjunct appointment in the student's administrative home department or school.
Graduate Program Review

I. Purpose

Michigan Technological University conducts formal review of its graduate programs on a regular schedule in order to promote continual improvement. The University Procedure for Periodic Review of Academic Departments and Schools is available on the Provost’s website at: http://www.admin.mtu.edu/admin/prov/PARTICIPATING%20PROGRAM%20REVIEW%20PROCEDURES.htm

II. Review Cycle

Each program, or set of programs in a related field that choose to be reviewed as a group, will be formally reviewed according to the schedule in the Procedure for Periodic Review of Academic Departments and Schools.

III. Responsibility and Locus of the Review

Reviews are initiated by the Provost as described in the Procedure for Periodic Review of Academic Departments and Schools.

IV. Schedule

The schedule for the review is the same as that described in the Procedure for Periodic Review of Academic Departments and Schools.

V. The Self-Study

The self study will be conducted and include the components described in the Procedure for Periodic Review of Academic Departments and Schools. The data related to graduate education to be collected as part of the self-study are listed in Appendix A of this report, Self-Study Guidelines. During the fall semester of the review year the Graduate School will provide the programs being reviewed with most of the quantitative data required for the Self-Study of graduate programs.

VI. External Reviewers

See Procedure for Periodic Review of Academic Departments and Schools.

VII. Internal Reviewer

See Procedure for Periodic Review of Academic Departments and Schools.

VIII. Review Summary Report

See Procedure for Periodic Review of Academic Departments and Schools.

IX. Dean’s Evaluation

See Procedure for Periodic Review of Academic Departments and Schools.
X. Provost’s Report

See Procedure for Periodic Review of Academic Departments and Schools.

XI. History of Revisions or Changes

- 09/03/10 Draft document prepared by dean of the Graduate School reviewed by a subcommittee of the Graduate Faculty Council.
- 10/15/10 Revised according to Graduate Faculty Council subcommittee comments.
- 10/21/10 Revised to follow format of Procedure for Periodic Review of Academic Departments and Schools.
Appendix A: Self-Study Guidelines for Graduate Program Periodic Review

These guidelines should be reviewed annually by the Graduate Dean and programs which have been recently reviewed so that they can be continually revised and improved.

I. Quantitative Data Collected by the Graduate School

Data collected by the Graduate School and provided to programs at the start of the self-study period. The "goal" column will be filled in by the unit preparing the self-study if the unit chooses to use that column to set goals for itself as a way to internally prioritize resource and effort allocation in the future.

Program Name(s): __________________________________________________________________________________________

Table 1: Number of Graduate Faculty Employed by Michigan Tech by Rank and Year: Headcount and (FTE). (Use parentheses to indicate FTE data.)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Professor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate Professor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Professor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Professor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Engineer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Rank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Faculty Demographics.

<table>
<thead>
<tr>
<th>Demographic Percentages</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Female Faculty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% White Non-Hispanic Faculty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Asian-American Faculty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Faculty Scholarly Activity by Year.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer-Reviewed Publications/FTEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citations/FTEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Faculty (Headcount) with Grants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Faculty Involvement in Graduate Education.

<table>
<thead>
<tr>
<th>Number of Faculty</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving as PhD Advisor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serving as Master’s Advisor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serving on PhD Committees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serving on Master’s Committees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Applications and Admissions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admits without Funding Offers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admits with Funding Offers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristic</td>
<td>Year 1 20XX</td>
<td>Year 2 20XX</td>
<td>Year 3 20XX</td>
<td>Year 4 20XX</td>
<td>Year 5 20XX (Final)</td>
<td>Year 5 + 5 20XX (Goal)</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Enrolled without Funding Offers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enrolled with Funding Offers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of New PhD Students Entering without a Master’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of New PhD Students Entering with a Master’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of PhD Students that Converted from a Master’s Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of PhD Students Leaving the Program*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Master’s Students Converted from a PhD Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Master’s Students Leaving the Program*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Students leaving the program are defined as those who have failed to comply with the continuous enrollment policy for at least two of the most recent academic-year semesters. Date of attrition should be first semester following last enrollment.

Table 6: Entering Class.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Verbal GRE Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Quantitative GRE Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Analytical GRE Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Undergraduate GPA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate or Previous Graduate Institution(s) (List)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Student Demographics.

<table>
<thead>
<tr>
<th>Demographic Percentages</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Female PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% White Non-Hispanic PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Asian-American PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Female Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% White Non-Hispanic Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8: Graduate Student Degree Completion Progress. *In each cell indicate total number and percent female, domestic, and non-White/non-Hispanic.*

<table>
<thead>
<tr>
<th>Demographic Percentages</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Asian-American Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 8: Graduate Student Degree Completion Progress. In each cell indicate total number and percent female, domestic, and non-White/non-Hispanic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>PhD Students Enrolled</td>
</tr>
<tr>
<td>PhD Graduates</td>
</tr>
<tr>
<td>Minimum / Maximum / Average Time to Comprehensive Exam (Subject-Area) for PhD Graduates During Year Indicated</td>
</tr>
<tr>
<td>Minimum / Maximum and Average Time to Qualifying Exam (Research Proposal) for PhD Graduates During Year Indicated</td>
</tr>
<tr>
<td>Minimum / Maximum and Average Time to Degree for PhD Graduates During Year Indicated</td>
</tr>
<tr>
<td>Research Master’s Students Enrolled (Plan A or B)</td>
</tr>
<tr>
<td>Research Master’s Students Graduated (Plan A or B)</td>
</tr>
<tr>
<td>Minimum / Maximum and Average Time to Degree for Research Master’s Graduates During Year Indicated (Plan A or B)</td>
</tr>
<tr>
<td>Professional Focus Master’s Students Enrolled (Plan C or D)</td>
</tr>
<tr>
<td>Professional Focus Master’s Students Graduated (Plan C or D)</td>
</tr>
<tr>
<td>Minimum / Maximum and Average Time to Degree for Professional Focus Master’s Graduates During Year Indicated (Plan C or D)</td>
</tr>
</tbody>
</table>
Table 9: Graduate Student Funding. *In each cell indicate total number and % supported by internal and external funds (Internal = GTA, GA, GTI, FELI; External = GRA, FELE).*

<table>
<thead>
<tr>
<th>Number</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year PhD Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd-4th Year PhD Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th Year PhD Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;5 Years PhD Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Year Research Master’s Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Year Research Master’s Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2 Years Research Master’s Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Focus Master’s Students Receiving Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

II. **Quantitative Data Collected by the Program(s).**

Additional data must be provided by the program(s). Goals will be identified by the units preparing the self-study report. The “goal” column will be filled in by the unit preparing the self-study if the unit chooses to use that column to set goals for itself as a way to internally prioritize resource and effort allocation in the future.

Program Name(s): ____________________________________________________________

Table 10: Research Involving Graduate Students.

<table>
<thead>
<tr>
<th>Number</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer-Reviewed Publications with PhD Student as First Author</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer-Reviewed Publications with PhD Student as Coauthor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Year 1 20XX</td>
<td>Year 2 20XX</td>
<td>Year 3 20XX</td>
<td>Year 4 20XX</td>
<td>Year 5 20XX (Final)</td>
<td>Year 5 + 5 20XX (Goal)</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Peer-Reviewed Publications with Research Master’s Student as First Author</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer-Reviewed Publications with Research Master’s Student as Coauthor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral / Poster Presentations at Professional Meetings by PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral / Poster Presentations at Professional Meetings by Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Teaching Experiences for Graduate Students.

<table>
<thead>
<tr>
<th>Number</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTA/GTI Duty Required for PhD Students? (Yes, No)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Number of Laboratory or Recitation Sections Taught per Semester by PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Number of Lecture Sections Taught per Semester by PhD Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GTA/GTI Duty Required for Master’s Students? (Yes, No)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Number of Laboratory or Recitation Sections Taught per Semester by Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Number of Lecture Sections Taught per Semester by Master’s Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12: Post-Graduation Activities.

<table>
<thead>
<tr>
<th>Number of Indicated Type of Student (PhD or MS) Graduating in Indicated Year</th>
<th>Year 1 20XX</th>
<th>Year 2 20XX</th>
<th>Year 3 20XX</th>
<th>Year 4 20XX</th>
<th>Year 5 20XX (Final)</th>
<th>Year 5 + 5 20XX (Goal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD Students Going Directly to Tenure-Track Positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD Students Going Directly to Post-Doc Positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Indicated Type of Student (PhD or MS) Graduating in Indicated Year</td>
<td>Year 1 20XX</td>
<td>Year 2 20XX</td>
<td>Year 3 20XX</td>
<td>Year 4 20XX</td>
<td>Year 5 20XX (Final)</td>
<td>Year 5 + 5 20XX (Goal)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>PhD Students Going Directly to Position in Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD Students Going Directly to Position in Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhD Students with no Positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master’s Students Going Directly to a PhD Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master’s Students Going Directly to Post-Secondary Education Positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master’s Students Going Directly to Position in Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master’s Students Going Directly to Position in Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master’s Students with no Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III. Qualitative Data Collected by the Program(s)

Surveys will be administered to volunteer students (current and former) online. Responses will be returned to the Graduate School where they will be aggregated into two groups (current students/former students) and provided to the program. The identity of the respondents will be kept confidential.

A. Questions for Current Students:
   1. Was Michigan Tech your first choice for graduate school? If not, what was your first choice?
   2. Are you PhD or master’s student? If master’s, do you plan to write a thesis?
   3. Are you planning to earn a certificate as well as your degree?
   4. Are you planning to earn more than one degree (e.g., master’s and PhD or master’s in more than one field)?
   5. What were you doing before graduate school? If at University, which one?
6. While a graduate student have you traveled to a conference? If so, did you give an oral or poster presentation? If so, how was the trip paid for?
7. Have you had a paper published in a peer-reviewed journal or equivalent? If so, were you the first author?
8. Have you written a proposal for external or internal funding (e.g., for fellowship, research grant, or other)?
9. Have you had financial support? If so, of what type? If so, how many hours on average did you work per week? If a TA, were you given training or support for teaching?
10. What are your primary and secondary career goals?
11. Have you had an internship or co-op position?
12. Were your graduate program’s goals for its students clear to you before you came to Michigan Tech?
13. Are you a peer mentor?
14. Are your colleagues (other graduate students) supportive of one another?
15. Are there opportunities for social interactions with the other graduate students in your program?
16. Are there opportunities for social interactions with faculty and staff?
17. Do you have an advisor?
18. Do you have a faculty or staff member mentor who is not also your advisor?
19. Is your progress in graduate school formally reviewed with you at least one time per year? If so, who communicates with you about the review (e.g., department chair, graduate program director, or advisor)?
20. Are you encouraged to interact with faculty and/or students outside of your home department?
21. Are you encouraged to take courses outside of your home department?
22. Have you identified your external committee member? If so, in what year of your graduate program did you add this person to your committee?

Please rate the following for the overall program (Likert Scale of 1-5: outstanding, good, average, poor, very poor)

1. Teaching by faculty
2. Scholarly activity of faculty
3. Curriculum (courses) offered
4. Research conducted by graduate students
5. Advising of graduate researchers
6. Program quality
7. Computer resources
8. Laboratories or studios
9. Graduate student offices/workspaces
10. Scholarly interactions with peers
11. Social interactions

Please rate the following for the University overall (Likert Scale of 1-5: outstanding, good, average, poor, very poor, N/A)

1. Library
2. On-campus housing
3. Off-campus housing
4. Healthcare
5. Health insurance
6. Childcare
7. Social interaction spaces
8. Recreational/athletic activities

B. Questions for Former Students:
1. Were you PhD or master’s student? If master’s, did you write a thesis?
2. Did you earn a certificate as well as a degree?
3. Did you earn more than one graduate degree at Michigan Tech (e.g., master’s and PhD or master’s in more than one field)?
4. What are you doing professionally at this time?
5. Do you feel your graduate education at Michigan Tech prepared you well for your career?
6. Would you recommend Michigan Tech to prospective graduate students in your field?

Please rate how well you feel your program prepared you to: (Likert Scale of 1-5: very well, well, average, poorly, very poorly)

1. Make oral presentations.
2. Prepare written reports.
3. Write proposals for resources.
4. Think critically about technical issues in your field.
5. Learn material on your own.
6. Manage your time.
7. Supervise others.
8. Think “outside the box.”

Do you have any suggestions on how the graduate program in which you completed your degree might be improved?

IV. Other Narrative Information

Suggested types of other information that program may wish to address in the self-study of its graduate programs are listed below.

1. Program Goals: What are the goals for the program(s)? (For example, at the PhD level is the intent to produce researchers in a particular area of the discipline? Is the goal to produce future faculty? Is the goal to produce researchers for industry? At the master’s level is the goal to emphasize research or professional preparation?)
2. Alignment: How do the programmatic goals align with the University Strategic Plan?
3. Resources: How are resources (money, space, faculty and staff time) allocated in support of the goals?
4. Innovative Practices: Are some practices being employed that are particularly effective or promising? (For example, REU-based recruiting, peer-mentoring, TA-training/support, proposal preparation training, career preparation training, awards for outstanding achievements, travel support for meetings, departmental-level grievance process, formal annual review of graduate students, etc.).
5. Points of Pride: Notable achievements, recognitions, etc.
6. Collaboration: Describe new or existing collaborations. These may be international, interdisciplinary, multi-university, etc.
7. Challenges: What challenges exist that may make it difficult to reach the goals?
8. New Initiatives: Are any new initiatives currently planned?
Graduate School Conditional/Provisional Admit

The following will be a change made to the Provisional/Conditional Admit language effective immediately. This update is being made to be in line with what is current practice in several areas (PhD in Biomedical Engineering, MS in Computer Engineering).

Current Language:

Provisional/Conditional Admit

The Graduate School does not offer a provisional or conditional admit. Students who wish to take graduate courses prior to full acceptance in a program may apply for nondegree graduate status.

New Language:

Provisional Admission

Some programs offer provisional admission to applicants who have academic deficiencies that must be corrected before the applicant can receive full admission to the graduate program. Students who are provisionally admitted must satisfy specific requirements by taking prerequisite courses before they are eligible to earn a graduate degree. Typically the provisional admission requirements must be completed within a set amount of time. Students who successfully complete the requirements within the time limit will receive full admission to the graduate program. Domestic students who fail to complete the requirements within the time limit may have their status changed to non-degree seeking. International students who fail to complete the requirements within the time limit will NOT receive full admission to the graduate program.

Graduate programs/departments will monitor provisionally accepted students and notify the Graduate School about students who do not complete the requirements.

Students who do not qualify for provisional admission and students who apply to programs that do not offer provisional admission are eligible to apply as non degree seeking students.

Conditional Admission

Academically eligible students who do not meet the English language proficiency requirements for their intended graduate program may be granted conditional admission in order to successfully complete training in our English as a Second Language program (ESL). Conditionally admitted students are eligible to activate a preexisting application to a graduate program after completing the ESL program. Admission to a graduate program is not guaranteed for conditionally admitted students.
Figure 1. Number of finishing fellowship applications per semester since spring 2009. The fall 2009 and 2010 applications have been accepted in the spring and summer of those years.

Changes to future finishing fellowship competitions:
- Limit applications to two attempts per student.
- Eliminate competition in the spring for fall fellowships.
FY11-09: Addressing Dissents (N. Byers-Sprague)

Current Situation:

Currently only the advisor and department chair/graduate program director need to sign page 2 of the “Report on Oral Examination” indicating that “The candidate addressed comments of the dissenting committee member and the final thesis/report/dissertation copy is accepted without further revision or correction.”

Issue of Concern:

Recently a dissenting examiner expressed concern when faced with the pressure of a short time line to review a revised document and noted that there is opportunity for an advisor to sign page 2 without the student fully addressing issues raised by the dissenting examiner. Would adding the requirement of the signature of the dissenting examiner better ensure that all concerns were addressed?

Proposed Change:

Page 2 of the “Report on Oral Examination” would include a signature line for the dissenting examiner.
PROPOSAL FOR A
MASTER’S DEGREE PROGRAM IN
INTEGRATED GEOSPATIAL TECHNOLOGY

SUBMITTED BY THE
SURVEYING ENGINEERING PROGRAM, SCHOOL OF TECHNOLOGY
SCHOOL OF FOREST RESOURCES & ENVIRONMENTAL SCIENCE
MICHIGAN TECH RESEARCH INSTITUTE (MTRI)

1. GENERAL DESCRIPTION AND CHARACTERISTICS OF PROGRAM

Sustainable development of a society depends greatly on the availability and reliability of geospatial data. Terabytes of multi-dimensional geospatial data and metadata are acquired using various sophisticated instruments such as global navigation satellite systems, aerial and satellite panchromatic hyper-spectral remote sensors, high-precision optical-electronic surveying instruments, laser scanning systems, radar, sonar, etc. Data are used by scientists from many different disciplines such as engineering, geology, forestry, agriculture, social sciences, history, and political science to study diverse aspects of the Earth and human activity. All these disciplines use geospatial data and technology as a supplementary tool in their research, but geospatial data acquisition and processing is a science in itself.

The roots of geospatial technology are geodetic science, photogrammetry, cartography, surveying, topographic mapping, and thematic mapping. Combined with new technological developments in optics, electronics, and computing, these roots have produced a new blend of applied science – Integrated Geospatial Technology. Examples of recent applications of these technologies include: terrestrial and airborne laser scanning systems that are widely used to obtain 3D models of objects; high-resolution satellite imaging sensors that provide multi- and hyper-spectral video data which allow users to investigate spatial-temporal and physical properties of objects; and Global Navigation Satellite Systems that provide real-time and accurate geo-positioning and navigation data to define precise locations of objects on land and water, including man-made structures or natural features.

There is a large and growing need for scientists and engineers with advanced training in the geospatial technologies. In particular, there is a recognized need among different disciplines for more effective systems to gather, analyze, and interpret geographically referenced spatial data. Powerful new research and technological tools for addressing these problems require graduate-level training in the geospatial sciences.
In many cases, the same geospatial product, such as a Digital Terrain Model, can be created by different techniques. To achieve a goal, professionals need to reason and predict the spatial and semantic accuracy of the final product, compare different techniques and approaches, and estimate technological, financial, and manpower requirements. Planning the data acquisition process, balancing errors and accuracies, and combining and optimizing different technologies for data acquisition and adjustment requires professional knowledge integrated with skills spanning different aspects of quantitative geospatial techniques and technologies.

The proposed Master’s Degree is designed for students from a variety of backgrounds for careers in surveying, photogrammetry, remote sensing, Light Detection and Ranging (LiDAR), terrestrial laser scanning industries, and for allied areas that require knowledge and understanding of the acquisition, processing, and analysis of spatially referenced data.

2. RATIONALE

Current trends in industry and government agencies indicate that a stable demand exists for geospatial technology within multiple disciplines. In academia, a growing number of faculty and graduate students are using geospatial data within a variety of fields. Active research programs, courses, and a growing number of graduate degrees incorporate the use of such data and information. The Master’s Degree proposed here will support ongoing activities by facilitating interdisciplinary collaboration in graduate education, and will add value to Michigan Tech’s current graduate offerings by providing a suite of courses in the area of Integrated Geospatial Technology.

The design of this proposed graduate program specifically addresses the following goals:

- Provide a flexible interdisciplinary structure to ensure the best positioning of its graduates in job markets.
- Allow for rapid response to the current demands of industry and foreseeable future trends.
- Incorporate state-of-the-art geospatial research and technology.
- Attract current students of Michigan Tech as well as students at other universities nationally and internationally.
- Promote flexibility in terms of staffing, research interests, practical expertise and modes of course delivery.
- Promote sustainable research infrastructure and staffing in the area of geospatial science and technology at Michigan Tech.

The proposed Master’s Degree is viewed as the initial stage in the strengthening of geospatial science and technology at Michigan Tech. As interest in graduate geospatial education grows and the campus becomes more familiar with the needs and interests of students in this program, the Master’s program could be scaled-up to an interdisciplinary PhD program.
3. Discussion of related programs within the institution and at other institutions

Very few higher education institutions offer baccalaureate degree programs focused specifically on geospatial technology and GIScience per se. Berdusco ¹ identified about 425 higher education institutions worldwide (about 260 in the US) that offer formal certificate, diploma, or degree programs in GIS and GIScience.

Of the 28 US universities listed as offering undergraduate degree programs in GIS, all but four in fact offer B.A. and B.S. degrees in Geography (nineteen programs.) Others offer baccalaureate degrees in Earth Science, Environmental Science, Natural Resources, or Forestry, with concentrations, specializations, tracks, or undergraduate certificates in GIS, GIScience, cartography, and related topics.

For the same reasons that the geospatial workforce is diffused among many industries in every employment sector, geospatial activities tend to be widely dispersed and poorly coordinated on four-year college campuses. Within academic programs, courses involving geospatial technologies are often positioned as intermediate or advanced technical specialties with prerequisites and class size limits that pose barriers to enrollment.

A small number of US universities offer graduate degrees in separate quantitative geospatial disciplines such as Surveying (Purdue, University of Texas at Corpus Christi, Florida), Photogrammetry (Ohio State) and Cartography (Penn State, Kansas), but there is no university in the US offering Integrated Geospatial Technology.

4. Projected enrollment

The Michigan Tech Surveying Engineering program’s Advisory Board has expressed its support for establishing a graduate program in Integrated Geospatial Technology. The Board felt that there would be strong demand from industry for graduate students with the expertise that would be gained through participation in a certificate or Master’s program.

There are currently five students in the Surveying Engineering program who have expressed an interest in completing a Master’s degree. We expect 5-10 students a year will enroll in the proposed Master’s program.

We strongly believe that the unique structure of the proposed graduate program curriculum and the availability of online course delivery will attract additional non-degree seeking post-graduate students nationally and internationally.

5. Scheduling plans

The classes will be taught on the Michigan Tech campus and most of them will have the option for online delivery.

¹ Berdusco, B., Results of a Survey of Known Higher Education Offerings in GIS and GISci (2003), http://www.ucgis.org/priorities/education/GIS_Cert+Masters_Prog/Berdusco.htm
6. CURRICULUM DESIGN

MASTER OF SCIENCE PROGRAM:

Table 1 outlines options and requirements for the proposed Master of Science degree in Integrated Geospatial Technology.

<table>
<thead>
<tr>
<th>Program</th>
<th>Option</th>
<th>Coursework</th>
<th>Thesis Research</th>
<th>Engineering Report or Practicum</th>
<th>Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>Plan A</td>
<td>≥20</td>
<td>6-10</td>
<td></td>
<td>≥30</td>
</tr>
<tr>
<td>MS</td>
<td>Plan B</td>
<td>≥24</td>
<td></td>
<td>2-6</td>
<td>≥30</td>
</tr>
<tr>
<td>MS</td>
<td>Plan C</td>
<td>≥30</td>
<td></td>
<td></td>
<td>≥30</td>
</tr>
</tbody>
</table>

The Master’s program is designed to represent the diversity within the body of knowledge that comprises Integrated Geospatial Technology. The specific set of courses a student takes to meet the requirements of the degree is meant to be flexible to allow a customized program that will satisfy specific research or project interests. It is assumed that each student will take at least 2 courses from at least 2 different areas and specialize in one area in order to understand the essence of integrated approaches to solving real life problems.

7. COURSE DESCRIPTIONS

There are three groups of courses: A) required, B) professional electives, and C) supporting electives. The required group consists of three courses (6 credits), an introduction to the geospatial field, research methods and a research seminar.

The professional electives group provides the set of core courses for the degree. These courses are grouped into Geomatics, GIScience, Remote Sensing, and Geospatial Metadata and Cartography. The variety of courses provides flexibility for specific coursework selection depending on a student’s area of specialization. For example, a student interested in pursuing an emphasis in Geodetics would be advised to take the Fundamentals of Remote Sensing (GE4250) course and the introductory one credit course (SU5003) combined with Computational Geosciences to fulfill a GIS component. As another example, students interested in pursuing environmental geospatial applications might be advised to select FW5510, FW5540 and FW5560.

Supporting courses can be useful for tailored preparation of graduate students for specific career paths. This group includes courses in robotics and computer science, which could serve the needs of a student interested in the aerospace industry; and courses in environmental policy and decision making for students seeking employment with governmental agencies.

The actual program of study for each student will be developed in consultation with an advisor and will be based on individual educational goals.

A. REQUIRED COURSES

SU5010 Geospatial Concepts, Technologies and Data (3 credits), (course exists, delivery: Dr. Eugene Levin)

High-level review of geospatial data acquisition systems, sensors and associated processing technologies. Course considers geospatial metadata generation principles, interoperability, and major tools for manipulation with geospatial data. Course may help in transition of non-geospatial majors to geospatial field.
**FW 5810 Research Methods in Natural Resources (2 credits) (course exists, delivery: SFRES faculty)**
Overview of science and scientific research. The process of graduate education including choosing an advisor, selecting a research problem, writing a thesis proposal, scientific hypothesis testing, analyzing data, and communicating results through various media.

**SU5800 Graduate Seminar (1 credit), (new course, delivery: participating faculty)**
Student presentation of current geospatial research in a traditional seminar setting.

### B. PROFESSIONAL ELECTIVE COURSES

#### I. GEOMATICS

Geomatics courses are designed to provide students with the knowledge required to collect geographic information, prepare it for use, and take into account the inherent measurement errors typically encountered.

**SU5020 Data Analysis and Adjustments (3 credits), prerequisite SU3250(C) or equivalent (course exists, delivery: Dr. Alfred Leick)**
Course explores fundamentals of mathematical error propagation theory including various observation equations, least squares adjustments, and Kalman filter methods. Blunder detection, decorrelation, and inversion of patterned and large matrices processes are considered. Involves analysis of position estimation deploying geospatial measurements.

**SU5021 Geodetic Models (3 credits), prerequisite SU5020(C) (course exists, delivery: Dr. Alfred Leick)**
Course provides solid geospatial background in geodetic reference frames: datums; geoids; and reference ellipsoids. 2D and 3D geodetic network adjustments are considered based on 3D spherical models.

**SU5022 Positioning with GNSS (3 credits), prerequisite SU5020 or equivalent (course exists, delivery: Dr. Alfred Leick)**
In depth study of GPS, GLONASS, Galileo, COMPASS satellite systems, theory, and processing of global positioning measurements. Strongly recommended for geospatial practitioners.

#### II. GEOGRAPHIC INFORMATION SCIENCE (GISc)

The courses in Geographic Information Science provide students with an introduction to the information science issues associated with processing and displaying geographical data.

**SU5023 Geospatial Positioning (3 credits), (course exists, delivery: Colin Brooks)**
High-level summary of GPS-GAP courses. This course is intended for interdisciplinary graduate students who seek just ONE combination course in adjustments, geodesy and GPS (with emphasis on GPS/GNSS). Not available to students who have taken SU5020, SU5021, SU5022.

**SU5041 Geospatial Data Processing (3 credits), (course exists, delivery: Dr. Yerach Doytsher)**
Advanced data collection techniques; raster to vector; data conversion and map projections; topology; principles and application via advanced spatial analysis; advanced database structure; geo-database; geo-relational data model versus object-component data model; advanced 3D applications – vector and raster data model application; network analysis; linear referencing and conflation; geo-coding, GIS-CAD integration; web-based GIS innovations.

**SU5043 Topographic Analysis (3 credits), (course exists, delivery: Dr. Yerach Doytsher)**
LiDAR measurements; DSM - data sources, accuracy analysis, quality control, vector data analysis; terrain representation and TIN; grid analysis - interpolation, visibility, filers (smoothing, edges, median); shading;

---

2 Professor, Department of Spatial Information Science and Engineering, University of Maine; Adjunct Professor, Michigan Tech
3 Senior Research Scientist, Michigan Tech Research Institute (MTRI)
4 Professor, Civil and Environmental Engineering, Technion-Israel Institute of Technology
merging overlapping DSMs; spatial analysis - spectral analysis shape analysis; automatic feature extraction from DSM.

III. REMOTE SENSING

The courses in Remote Sensing provide a background in wireless or non-contact methods of obtaining information related to geospatial objects.

SU5002 Infrared Technology, Sensors, and Applications (1 credit), (course exists, delivery: Dr. Robert Schuchman)
Infrared remote sensing fundamentals, current and future technologies, and applications are considered. Remote sensing for both civilian applications such as environmental resource mapping and military applications will be included.

SU5930 Synthetic Aperture Radar (SAR) Fundamentals and Applications (3 credits), (course exists, delivery: Dr. Robert Schuchman)
Review of radar concepts, applications of SAR (InSAR) data, types of available satellite/airborne systems, and data processing methods. Applications for creating topographic data, recognizing targets, classifying ice and vegetation, and oceans/large lakes will be presented based on real-world examples.

FW5560 Digital Image Processing: Remote Sensing Perspective (3 credits), (course exists)
Presents the theory and quantitative procedures of digital image processing using remotely sensed data. Emphasizes image acquisition, preprocessing, enhancement, transformation classification techniques, accuracy assessment, and out-products. Discusses linkages to GIS. Also covers evaluating applications of the technology to current resource management problems via peer-reviewed literature.

IV. GEOSPATIAL METADATA AND CARTOGRAPHY

This group of courses provides the knowledge and background to understand the science of describing data and visualization in different types of maps.

SU5042 Digital Cartography (3 credits), (course exists, delivery: Dr. Yerach Doytsher)
Spatial relations - topology, relations and relationships, directions and distances; hierarchy; generalization - vector (linear, polygonal, fractals) and raster; labeling - automatic name placement, text arrangement and deletion text; computational geometric algorithms - line intersection, polygonal relationships, grid model, route analysis.

SU3540 Geospatial Information Technology with Elements of Field Cartography (4 credits), prerequisite MA3710 (course exists, delivery: Dr. Eugene Levin)
Application of GIS technology methods for processing surveying data obtained in the field. Concepts of interoperability and metadata organization are considered. Includes map projection review and 2D and 3D cartographic data visualization.

B. SUPPORTING ELECTIVE COURSES

EE 5725 - Mobile Robotics & Multi-Robot Systems (3 credits)
Introduction to mobile robotics and multi-robot systems. Introduce spatial description, mobile robot locomotion, kinematics, localization and mapping, motion planning and navigation. Topics in multi-robot systems include biological inspirations, control structure, inter-robot communication, learning in multi-robot systems, and modeling and analysis.

EE 5522 - Digital Image Processing (3 credits) (course exists)
Image formation, enhancement, and reconstruction. Applications in medical imaging, computer vision, and pattern recognition.

---

5 Co-Director, Michigan Tech Research Institute (MTRI)
CS 5611 - Computer Graphics: Advanced Rendering and Animation (3 credits) (course exists)
Topics include polygonal objects, parametric curves and surfaces, lighting models, shadows and textures, ray-tracing techniques, radiosity methods, volume rendering, and animation.

CS 5811 - Advanced Artificial Intelligence (3 credits) (course exists)
Course topics include current topics in artificial intelligence including agent-based systems, learning, planning, use of uncertainty in problem solving, reasoning, and belief systems.

FW 5540 - Advanced Terrestrial Remote Sensing (4 credits) (course exists)
Remote sensing principles and concepts at the graduate level. Topics include camera and digital sensor arrays, types of imagery, digital data structures, spectral reflectance curves, applications and introductory digital image processing.

FW 5550 - Geographic Information Systems (4 credits) (course exists)
Use of geographic information systems (GIS) in resource management. Studies various components of GIS in detail, as well as costs and benefits. Laboratory exercises use ArcGIS software package to solve resource management problems.

FW 5560 - Digital Image Processing: Remote Sensing Perspective
Presents the theory and quantitative procedures of digital image processing using remotely sensed data. Emphasizes image acquisition, preprocessing, enhancement, transformation classification techniques, accuracy assessment, and out-products. Discusses linkages to GIS. Also covers evaluating applications of the technology to current resource management problems via peer-reviewed literature.

GE 4100 - Geomorphology and Glacial Geology (4 credits) (course exists)
The study of the processes, including fluvial, glacial, wind, mass movement, and wave action, shaping the earth's surface by erosion and deposition of geologic materials. Emphasizes the role of past and present climate. Field trips are a major component.

GE 4250 - Fundamentals of Remote Sensing (3 credits), (course exists)
This course focuses on the basic physics behind above-surface remote sensing and remote sensing systems. Topics covered include: properties of the atmosphere, absorption and scattering of electromagnetic radiation, instrument design, data acquisition and processing, validation, and basic applications.

SS 5300 - Environmental Policy and Politics (3 credits), (course exists)
An overview of environmental policymaking and politics in the U.S. Emphasizes policies regarding air and water pollution, toxics and hazardous waste. Discussion of rulemaking, enforcement, and administration of laws by EPA. Investigation of environmental politics on national and community levels, with focus on social movements and citizen participation.

SS 5350 - Environmental Policy Analysis (3 credits), (course exists)
The role of economic analysis in environmental policy, including a detailed review of the major tools that are used at the federal, state, regional, and local levels. Special emphasis on benefit-cost analysis and comparative risk analysis.

SU 4140 - Photogrammetry (3 credits) (course exists)
Basic principles of photogrammetry and its role as a technology for spatial data collection. Use of photogrammetry in the fields of surveying, engineering, and geographic information management will be discussed.

SU 4100 - Geodetic Positioning (3 credits) (course exists)
Introduction to the instruments and procedures used in surveying projects that require a high level of accuracy. Discusses some conventional instruments and techniques but the greater emphasis is on GPS techniques.
8. LIBRARY AND OTHER LEARNING RESOURCES

The library has basic literature in the area of geospatial technologies but the following additional books and journals would be required.

LIST OF BOOKS (APPROXIMATE COST: $2,000)

LIST OF JOURNALS (APPROXIMATE ANNUAL COST: $12,345)
1. *GPS Solutions*, Springer, ISSN: 1080-5370 (Available through SpringerLink)
9. COMPUTING ACCESS FEE

A computer access fee of $210 (2010-11) per semester will be required for students enrolled in this program and additional university Distance Learning fees may be required for on-line courses.

10. FACULTY RESUMES

Colin Brooks (http://expertise.cos.com/cgi-bin/exp.cgi?id=1265087)
Yerach Doytsher, PhD (http://www.technion.ac.il/~doytsher/13.htm)
Michael Falkowski, Ph.D (http://forest.mtu.edu/faculty/falkowski/)
Alfred Leick, PhD (www.gnss.umaine.edu)
Eugene Levin, PhD, CP (http://www.tech.mtu.edu/Faculty_Pages/Eugene_Levin.html)
Ann MacLean, Ph.D (http://forest.mtu.edu/faculty/maclean/index.html)
Robert Schuchman, PhD (http://expertise.cos.com/cgi-bin/exp.cgi?id=1289668)
Aleksey Smirnov, Ph.D (http://www.geo.mtu.edu/profile/AVSmirnov.htm)
Igor Ternovskiy, PhD (www.intopsys.com)

11. DESCRIPTION OF AVAILABLE/NEEDED EQUIPMENT

The School of Technology has been teaching surveying engineering and photogrammetry for over 20 years. In terms of equipment, the School of Technology already has the following capital assets to support the new program.

- Trimble GNSS RTK system $60,000
- Trimble S6 total stations (4 pcs) $96,000
- TSC2 wireless data collectors (4 pcs) $10,000
- Leica DN Digital Levels (10 pcs) $30,000
- Trimble Geomatics Office (90 licenses) $400,000
- Arc GIS licenses (unlimited) (available via Michigan Tech)
- Carlson Civil Suite software (90 licences) $927,000
- SimWright StereoGIS softcopy photogrammetric workstation (5 licenses) $50,000
- Cardinal Systems VrMapping photogrammetric software suite (12 licenses) $120,000
- Chrysler PT Cruiser vehicle $6,700
- Small aerial UAV (in production with ME-EM aerospace student enterprise) $13,000
- RIEGL 3D Imaging Sensor LMS-Z210ii terrestrial LiDAR scanner $50,000

Total current assets are valued at $1,762,700.

The School of Technology and MTRI have all the necessary equipment and software licenses to start the proposed graduate degree program.
12. PROGRAM COSTS
The Graduate program may be started without additional costs since a portion of the distance learning tuition revenue will be used to support the external instructors. The plan is to have an agreement that pays the instructors a fixed amount per student with a cap on the maximum compensation per class. This means that classes with very low enrollment might not be offered if the instructor does not feel there is adequate compensation. Tuition revenue from classes with enrollment beyond the break-even point could possibly be used to subsidize low enrollment classes.

13. SPACE
Several shared graduate student offices will be required for full-time students (one room for each 5 students). In the event that a geospatial faculty member is hired as part the SFHI, an office in the School of Technology (EERC) might be needed in the future.

14. ACCREDITATION REQUIREMENTS
None

15. PLANNED IMPLEMENTATION DATE - FALL SEMESTER 2010

16. INTERNAL STATUS OF THE PROPOSAL
Approved by:

Date:
PROPOSAL FOR A
GRADUATE CERTIFICATE IN
INTEGRATED GEOSPATIAL TECHNOLOGY

SUBMITTED BY THE
SURVEYING ENGINEERING PROGRAM, SCHOOL OF TECHNOLOGY
SCHOOL OF FOREST RESOURCES & ENVIRONMENTAL SCIENCE
MICHIGAN TECH RESEARCH INSTITUTE (MTRI)

1. GENERAL DESCRIPTION AND CHARACTERISTICS OF PROGRAM

Sustainable development of a society depends greatly on the availability and reliability of geospatial data. Terabytes of multi-dimensional geospatial data and metadata are acquired using various sophisticated instruments such as global navigation satellite systems, aerial and satellite panchromatic hyper-spectral remote sensors, high-precision optical-electronic surveying instruments, laser scanning systems, radar, sonar, etc. Data are used by scientists from many different disciplines such as engineering, geology, forestry, agriculture, social sciences, history, and political science to study diverse aspects of the Earth and human activity. All these disciplines use geospatial data and technology as a supplementary tool in their research, but geospatial data acquisition and processing is a science in itself.

The roots of geospatial technology are geodetic science, photogrammetry, cartography, surveying, topographic mapping, and thematic mapping. Combined with new technological developments in optics, electronics, and computing, these roots have produced a new blend of applied science – Integrated Geospatial Technology. Examples of recent applications of these technologies include: terrestrial and airborne laser scanning systems that are widely used to obtain 3D models of objects; high-resolution satellite imaging sensors that provide multi- and hyper-spectral video data which allow users to investigate spatial-temporal and physical properties of objects; and Global Navigation Satellite Systems that provide real-time and accurate geo-positioning and navigation data to define precise locations of objects on land and water, including man-made structures or natural features.

There is a large and growing need for scientists and engineers with advanced training in the geospatial technologies. In particular, there is a recognized need among different disciplines for more effective systems to gather, analyze, and interpret geographically referenced spatial data. Powerful new research and technological tools for addressing these problems require graduate-level training in the geospatial sciences.

In many cases, the same geospatial product, such as a Digital Terrain Model, can be created by different techniques. To achieve a goal, professionals need to reason and predict the spatial and semantic accuracy of the
final product, compare different techniques and approaches, and estimate technological, financial, and manpower
requirements. Planning the data acquisition process, balancing errors and accuracies, and combining and
optimizing different technologies for data acquisition and adjustment requires professional knowledge integrated
with skills spanning different aspects of quantitative geospatial techniques and technologies.
The proposed graduate certificate is designed for students from a variety of backgrounds for careers in surveying,
photogrammetry, remote sensing, Light Detection and Ranging (LiDAR), terrestrial laser scanning industries, and
for allied areas that require knowledge and understanding of the acquisition, processing, and analysis of spatially
referenced data.

2. RATIONALE

Current trends in industry and government agencies indicate that a stable demand exists for geospatial technology
within multiple disciplines. In academia, a growing number of faculty and graduate students are using geospatial
data within a variety of fields. Active research programs, courses, and a growing number of graduate degrees
incorporate the use of such data and information. The graduate certificate proposed here will support ongoing
activities by facilitating interdisciplinary collaboration in graduate education, and will add value to Michigan Tech’s
current graduate offerings by providing a suite of courses in the area of Integrated Geospatial Technology.

The design of this proposed graduate certificate specifically addresses the following goals:

• Provide a flexible interdisciplinary structure to ensure the best positioning of its graduates in job
  markets.
• Allow for rapid response to the current demands of industry and foreseeable future trends.
• Incorporate state-of-the-art geospatial research and technology.
• Attract current students of Michigan Tech as well as students at other universities nationally and
  internationally.
• Promote flexibility in terms of staffing, research interests, practical expertise and modes of course
delivery.
• Promote sustainable research infrastructure and staffing in the area of geospatial science and
  technology at Michigan Tech.

The proposed graduate certificate is part of an effort to strengthen geospatial science and technology at Michigan
Tech.

3. DISCUSSION OF RELATED PROGRAMS WITHIN THE INSTITUTION AND AT OTHER
   UNIVERSITIES

Refer to the proposal for the Master’s Degree Program in Integrated Geospatial Technology.

4. PROJECTED ENROLLMENT

The Michigan Tech Surveying Engineering program’s Advisory Board has expressed its support for establishing a
graduate program in Integrated Geospatial Technology. The Board felt that there would be strong demand from
industry for graduate students with the expertise that would be gained through participation in a certificate or
Master’s program.
Currently, there are five industry professionals who have expressed interest in a graduate certificate and we anticipate approximately ten students participating in the program at any point in time.

We strongly believe that the unique structure of the proposed graduate certificate and the availability of online course delivery will attract additional non-degree seeking post-graduate students nationally and internationally.

5. **Scheduling Plans**

The classes will be taught on the Michigan Tech campus and most of them will have the option for online delivery.

6. **Curriculum Design**

Certificate:
All of the courses in the proposed Master’s program, except Graduate Research, will be available to students seeking the graduate certificate. Any combination of fifteen credits may be selected depending on the technical emphasis area of the student. Example groups of courses oriented towards particular areas of emphasis are provided below. This allows each student to create a personalized program of study.

- **Surveying Engineering and GPS**: SU5010, SU5020, SU5021, SU5022, SU5042
- **GIS and 3D Visualizations**: FW5560, SU5010, SU5041, SU5042, SU5043
- **Remote Sensing and GIS**: FW5550, SU5001, SU5002, FW5560, SU5010, SU5023, SU5930
- **Automated Cartography and GIS**: FW5550, SU5001, SU5002, FW5560, SU5041, SU5043
- **Manned & Unmanned Robotic Platforms (UAV/UGV) Guidance, Navigation and Control (Geospatial Background)**: FW5560, SU5010, SU5022, SU5041, SU5042
- **Interdisciplinary**: SU5021, SU5022, SU5041, SU5042, SU5930

7. **Course Descriptions**

Refer to the proposal for the Masters Degree Program in Integrated Geospatial Technology.

8. **Library and Other Learning Resources**

Refer to the proposal for the Master’s Degree Program in Integrated Geospatial Technology.

9. **Computing Access Fee**

A computer access fee of $210 (2010-11) per semester will be required for students enrolled in this program and additional university Distance Learning fees may be required for on-line courses.

10. **Faculty Resumes**

Colin Brooks (http://expertise.cos.com/cgi-bin/exp.cgi?id=1265087)

Yerach Doytsher, PhD (http://www.technion.ac.il/~doytsher/13.htm)

Michael Falkowski, Ph.D (http://forest.mtu.edu/faculty/falkowski/)

Alfred Leick, PhD (www.gnss.umaine.edu)
11. DESCRIPTION OF AVAILABLE/NEEDED EQUIPMENT

The School of Technology has been teaching surveying engineering and photogrammetry for over 20 years. In terms of equipment, the school has the capital assets to support the new program.

12. PROGRAM COSTS

The graduate certificate program may be started without additional costs since a portion of the distance learning tuition revenue will be used to support the external instructors. The plan is to have an agreement that pays the instructors a fixed amount per student with a cap on the maximum compensation per class. This means that classes with very low enrollment might not be offered if the instructor does not feel there is adequate compensation. Tuition revenue from classes with enrollment beyond the break-even point could possibly be used to subsidize low enrollment classes.

13. SPACE

No additional space is required.

14. ACCREDITATION REQUIREMENTS

There are no accreditation requirements for the proposed graduate certificate.

15. PLANNED IMPLEMENTATION DATE

Spring Semester 2011.

16. INTERNAL STATUS OF THE PROPOSAL

Approved by:

Date: