Proposal for a

MASTERS PROGRAM AND GRADUATE CERTIFICATE IN INTEGRATED
GEOSPATIAL TECHNOLOGIES

Submitted by the Surveying Engineering Program

School of Technology and Michigan Tech Research Institute

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INTRODUCTION AND MOTIVATION

Our current proposal presents a significantly revised and re-developed version of the
original proposal presented at GFC on February 5, 2008. Proposal addresses concerns
and comments of GFC members. In the current version, section changes and revisions
are summarized.

Since in February 5, 2008 two proposals were presented (the earlier version of this
one and the Applied Spatial Information Sciences (ASIS) developed at School of
Forestry), it is necessary to underline the differences between the two proposals and
degrees. Specifically differentiating factors of current proposal compare to Applied
Spatial Information Science are:

1. Interdisciplinary ASIS program is to equip "non-geospatial" graduates with new
knowledge in GIS to broaden their professional perspectives in applying these
GIS knowledge in their areas of expertise (forestry, geology, biology etc). Interdisciplinary
in this case can be interpreted not as multi-disciplinary input
from different departments, but mostly as having and teaching students with
different backgrounds (and this is a very challenging task). It is obvious that
enrollment into this program will be mostly formed by MTU graduates. In
contrast Integrated Geospatial Technology (IGT) Degree is aimed at students
specializing in geospatial engineering and further mastering in Geomatics and
Geospatial Engineering. This degree is mostly designed for graduates from
corresponding Surveying Engineering program at MTU and other universities in
the US and Worldwide, offering specialized undergraduate degrees in geospatial
science and technology( Photogrammetric Engineering, Geodesy, Satellite
Geodesy, Gravmetry, Astro-Geodesy, Cartography,Remote Sensing, etc).

Thus, two proposed graduate degrees are based on different backgrounds,
and are targeting different goals and audiences. More details on potential
degrees evolving geospatial technologies are given in section 1 of the current
proposal.
2. Admission criteria’s and prerequisites for ASIS and Integrated Geospatial Technologies degrees are quite different. While ASIS students are assumed to have a background in environmental and natural resources disciplines – IGT students expected and required to have a stronger mathematical, physical, software, optical, electrical and overall engineering background. Detailed description of IGT prerequisites is given in section 7 for each proposed course. Conclusion: groups of IGT and ASIS students will be too much differentiating in background and starting-points for being placed in one classroom. This two degrees are different in spite of even courses names sounds similar. Context is totally different for ASIS and IGT students.(see section 7 for specific courses context)

3. Degrees names. Many correspondence we got as a feedback defines both degrees as “Two GIS proposals”. In spite of current IGT contains GIS courses, which are less than 20% of another coursework and are mostly GIS-DEVELOPMENT then GIS-APPLICATION oriented, proposed IGT degree is not correspond to GISscience body of knowledge. We may consider renaming degree back to “Geomatics Engineering”, which is significant part of our proposal. However, current “Integrated Geospatial Technology” title is proper in terms of marketing proposed degree outside of Michigan Tech.

Many GFC members advised to start with “less-ambitious” work plan based on existing resources and gradual program growth. In response was developed risk-minimized program implementation strategy encompassing 3 phases starting from existing courses Certificate and based on internal School of Technology resources only. This strategy described in details in section 2 of the current proposal.

IGT degree will also benefit from MTRI’s involvement in courses delivery and students’ projects.

We believe in successful start of IGT program in Fall 2008 to respond on Surveying Engineering graduates needs and Geospatial Engineering job markets trends Nationwide and Worldwide.

1. General description and characteristics of program.

Sustainable development of the society very much depends on availability and credibility of geospatial data. Terrabytes of geospatial data and metadata about the Earth are acquired using different sophisticated sensors and instruments such as global navigational satellite systems, aerial and satellite panchromatic and hyperspectral remote sensors, hi-precision optical-electronic surveying instruments, laser scanning systems, radars, sonars, etc. These data help scientists from many different disciplines such as geology, volcanology, forestry, agriculture, social sciences, demography, history and politics to study diversity aspects of the Earth and human phenomena. All these disciplines use this data and technologies as a supplementary tool in their research, but geospatial data acquisition and processing is an applied science and technology by itself.

The roots of these technologies are in geodetic science, photogrammetry, cartography, surveying and topographic and thematic mapping. Featured with new technological development in optics, electronics and computing, these roots emerge into a new
blend of applied science – integrated geospatial technologies. Terrestrial and airborne laser scanning systems are widely used to get 3D models of objects. High-resolution satellite imaging sensors provide multi- and hyper-spectral video data which allow the user to investigate spatial-temporal and physical properties of objects on the earth, ocean and atmosphere; Global Navigation Satellite Systems provide real-time accurate geo-positioning and navigation data to define precise location of objects not only on the land surface, but any features on the water, including man-made and wildlife creatures tracking.

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 in different disciplines to gather, analyze and interpret geographically referenced spatial information and data. Powerful new research and technological tools for addressing these problems require graduate-level training in the geospatial sciences for their effective use.

In many cases, the same geospatial product, for example Digital Terrain Model, can be created by different techniques. To achieve the goal, the professionals need to predict and reason spatial and semantic accuracy of the final product, compare different techniques and approaches, estimate technological and financial efforts as well as manpower. Planning data acquisition process, balancing errors and accuracies, combining and optimizing different technologies for data acquisition and adjustment require truly integrative, professional knowledge and skills in different directions of quantitative geospatial techniques and technologies.

The proposed Masters program and Graduate Certificate seeks to educate students from a variety of backgrounds for careers in the surveying, photogrammetric, remote sensing, LIDAR and terrestrial laser scanning industries, and for allied areas that require a knowledge and understanding of the acquisition, processing and analysis of spatially referenced data.

The degree program will offer two general options – Master of Applied Science and Master of Engineering with the emphasis on thesis and coursework respectively.

The Masters degree in Integrated Geospatial Technologies is an inherent component of the integrative MTU Geospatial Initiative, the educational part of which comprises the following components:

1. BS in Surveying Engineering (existing)
2. BS in Geospatial Engineering (to be developed at School of Technology)
3. Certificate and MSc in Integrated Geospatial Technologies (the current proposal)
4. MSc in Applied Spatial Information Sciences (inter-departmental program being developed by School of Forestry and Environmental Resources in co-operation with School of Technology, and School.
5. MSc in Geoinformatics (proposed inter-departmental program to be developed in co-operation with EE/EM/ME)
6. PhD in Geospatial Sciences and Geoinformatics (proposed inter-departmental program to be developed in co-operation with
All degrees will be implemented in the frame of the MTU’s Multi-disciplinary Integrated Geospatial Technology Center (Institute) of Excellence (IGTCE), which is aimed at establishing a geospatially-centered research environment and providing world-class knowledge and expertise for multi-disciplinary research in Environmental and Biological, Geosciences, Sustainable Development and Social Sciences, Information and Data Management Technologies.

2. Risk minimized sustainable implementation and resources management plan

As presented in previous section, the vision of the Michigan Tech Geospatial Education plan will directly match the University Strategic Plan for many years in future. After representation of this plan at the Graduate Faculty Council Meeting we were advised to work on a strategy that leads to self-sustainability of the program. To this end, we propose to split development of the degree program into 3 phases. It results in the following implementation plan:

**Phase I (Fall 2008)** – Start enrollments for Integrated Geospatial Technology Graduate Certificate. Certificate assumes choice of 15 academic credits from:
- 9 credits of *existing* Geomatics GPS-GAP 5000 level courses
- 6 credits of two new 4000 level courses which are *already planned and approved* for development in connection with the on-going improvement of SOT current Surveying Engineering program
- *Existing 6 credits of 4 5000 level courses offered by MTRI*

All courses are specified in section 7 of the current proposal. Phase I will not require any extra resources from the University. All the credits of the Certificate are part of the Masters degree offered at Phase II.

**Phase II (Starts spring 2009 – end based on enrollments)** – Creation of the complete 30 credits graduate program. Start enrollments for the program in fall 2008. The School of Technology is planning to deploy the following resources to support the development of new courses:
- Overhead funds generated by multiple geospatial research grants currently submitted or in the future, and from other sources;
- Funds generated by specific grants submissions devoted to the development of new graduate educational opportunities. Solicitation for such funds are available in NSF, NASA and other agencies;
- Funds generated by grants submission for non-government foundations.

As is seen from above, the School of Technology will not require any additional University Resources for Phase II. The risks of program development will be covered by School of Technology, based on its internal resources. Furthermore, preliminary calculations given in section 16 clearly indicates that enrollments of 10 new students for the graduate program (if no research funding will appear) will make it possible to open a new faculty line. *Only when financially-secured* by enrollment or by other
means, the new faculty lines will be opened in Phase II. Phase II will be culminated into the fully-functional 30 credits graduate program.

Phase III-OPTION, starting and ending based on students enrollments, anticipates an optional development of additional 21 credits courses. This development will be based only on successful enrollments and will be done by course purchases, and new course developments by existing and new faculty members. No investments or risks from University are anticipated at this stage. The starting of Phase III will indicate a break-even point in the program development. The additional courses will not only make it possible to generate attractive Integrated Geospatial Technology flexibility options specializing in Geomatics, Imaging or Cartography and visualization, but will also prepare a Tailored Geospatial Components for the Interdisciplinary Geoinformatics Degree which will be developed in cooperation with EE/EM/ME.

The proposed multi-phase program implementation strategy is risk-free for the University because of the following:

- The program starts based on existing courses and faculties;
- The new course development sources are internal and risk-free;
- The new faculty lines are enrollments/research grants based and thus financially secured.

The only visible drawback of the proposed strategy is the separation of the course-development and course-delivery processes. However, many universities in North America (for example Toronto University) are practicing such a risk-free approach to education which is exceptionally efficient in distance learning mode.

MTRI already successfully implements remote sensing geospatial courses. The proposed program will benefit from MTRI’s involvement in geospatial courses development and delivery. In addition, MTRI offers unique opportunities for Engineering Practicum and Internships. Graduate students will benefit from working on cutting-edge MTRI geospatial projects.

The proposed program implementation strategy is cost-efficient, risk-free and provides sustainable development of Geospatial Education and Research in Michigan Tech.

3. Rationale.

Current trends in technologies, industry and government agencies indicate stable demands for multi-disciplinary knowledge. In academia, a growing number of faculty and graduate students are using geospatial data and MTU is not an exception. Active research programs, courses, and a growing number of graduate degrees based on the use of such data and information already exist. This initiative is to build on this critical effort by developing a new inter-disciplinary degree program in the Integrated Geospatial Technologies. The initiative is based on the following statements

- The Graduate Program is designed as a flexible inter-disciplinary structure to ensure the best positioning of the graduates in job markets.
- The Graduate program should respond to current demand of industry and foresee future trends
• The Graduate program should reflect state-of-the-art geospatial research and technologies
• The proposed program is designed to attract students of MTU, other universities nationwide and internationally to the new integrated geospatial education option
• The inter-disciplinary structure of the program allows certain courses to be included into other degrees program at MTU
• The inter-disciplinary approach provides flexibility for the School in terms of staffing, research interests, practical expertise and modes of course delivery
• The graduate program is sought as an important component for developing sustainable research in Geospatial sciences and technologies at MTU

4. Discussion of related programs within the institution and at other institutions.

Very few higher education institutions offer baccalaureate degree programs focused specifically upon Geospatial technologies and GIScience per se. Berdusco (2003) identified about 425 higher education institutions worldwide (about 260 U.S.) that offer formal certificate, diploma, and degree programs in GIS and GIScience.

Of the 28 U.S. 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), 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.

The only few US universities offer graduate degree in separate quantitative geospatial disciplines such as Surveying (Purdue, UTexas at Corpus Christi, Florida), photogrammetry (Ohio State) and Cartography (Penn State, Kansas), but there is no university in the US offering the Integrated Approach to Geospatial Technologies.

5. Program commercialization strategy

a. Projected enrollment.

The Surveying Engineering program’s Advisory Board meeting (October 12th 2007) has expressed its support in establishing such a program and reassured that there is a strong demand from the industry and administrations in graduates both with Master of Sciences and Master of Engineering options.
There are five students in the Surveying Engineering program already expressing an interest in enrolling into the Master’s degree program. We anticipate that within three to five years the program will have 10 to 15 students on campus and 15 to 20 students on their workplace.

We strongly believe that the Masters program will attract diversity of students due to the integrated approach and the nature of the courses. Students will find the variety of courses in **cartography and photogrammetry** attractive where 40-60% of professionals are traditionally female.

b. **Program expansion strategy**

The Integrated Geospatial Technology graduate program will be unique in the United States. Therefore we expect the traditional MTU sources of applicants to be supplemented with those from multiple government agencies and industries. Non-traditional sources which will require marketing efforts include:

- Intelligence Government Agencies: NGA, CIA, TSI. In particular the NGA supports university programs and research. The structure of NGA academic initiatives is reproduced on Figure below

![Diagram of NGA Initiatives](image)

Engaging NGA will require a significant marketing effort. We expect support from the Interdisciplinary Studies Institute (ISI) to actively participation in member organization of NGA and other federal agencies.

- Aerospace Industry: nowadays most of the major companies in this industry are involved in geospatial projects and therefore need specialist in integrated geospatial technology and research.
- The example of ITC (The Netherlands) indicates that there is a need in geospatial education internationally. Therefore contacts with relevant UN universities may result in involvement of an international component in proposed program.

The most efficient way to approach these new markets is to participate in high-level geospatial intelligence symposiums such as GEOINT ([http://www.geoint2008.com/](http://www.geoint2008.com/)). A booth at such high-level forums can be an efficient means for increasing students enrollment. The Institute for the Application of Geospatial Technology at Cayuga Community College, Inc. (IAGT) ([http://iagt.org/](http://iagt.org/)) is an example of successfully using Geoint for promoting Geospatial training and education for the Intelligence...
Community. We expect help from the graduate faculty to prepare MTU’s presence at this kind of events.


The classes will be taught on the MTU campus and partly delivered online. Some courses will require fieldwork; non-thesis option courses will have the internship component as well.

7. Curriculum design (refer to format of degree audit form). Indicate subject areas to be used for Departmental GPA calculation.

Integrated Geospatial Technology graduate certificate, which will be developed at Phase I, encompasses 15 credits coursework. These courses are mostly covering Geomatics, Metadata Generation and Imaging aspects of Integrated Geospatial Engineering. Although the coursework exists in various formats we will be using the curricular process to realign it with the proposed numbers and titles.

Table 1 outlines Phase II and III option and requirements for Master of Science where students should earn 30 credits total including 12 or more credits of 5000-level courses.

<table>
<thead>
<tr>
<th>Program</th>
<th>Option</th>
<th>Course work</th>
<th>Thesis research</th>
<th>Course research</th>
<th>Engineering report</th>
<th>Engineering practicum</th>
<th>Total credits</th>
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<tbody>
<tr>
<td>MSc A</td>
<td>A</td>
<td>12</td>
<td>18</td>
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<td>30</td>
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<tr>
<td>MSc B</td>
<td>B</td>
<td>18</td>
<td>12</td>
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<tr>
<td>MSc C</td>
<td>C</td>
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<td>3</td>
<td>6</td>
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<td>30</td>
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<tr>
<td>MSc D</td>
<td>D</td>
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The program is designed to represent the diversity of the Body of Knowledge in Integrated Geospatial Technologies. It is assumed that each student will study a key course component and then specialize in a certain direction to understand the essence of integrated approaches in solving real life tasks.

Bellow are the names and descriptions of the courses in the order of the multi-phase development.

7.1 PHASE I. Graduate Certificate in Integrated Geospatial Technologies.

Any 15 credits of the following:

GS 5020 Data analysis and adjustments (2-0-1), prereq. SU3250 or similar from another University, (course exist)
Errors, stochastic and mathematical models, quadratic forms, linearization and variance-covariance propagation of multi-dimensional nonlinear functions, least-squares algorithm of observation equations, position estimation using surveying and GPS vector measurements; review of statistics and linear algebra. Error ellipses and
ellipsoids, propagation of estimated quantities, a priori information on parameters, adjustment of implicitly related observations and parameters, mixed model, condition equation model, sequential solutions, testing conditions on nonlinear parametric functions. Geometry of least-squares, definition of network coordinate systems, singularities, probability regions, minimal and inner constraints, invariant quantities, multivariate normal distribution, relevant statistical tests, type I/II errors, internal and external reliability, absorption of errors, blunder detection, decorrelation, inversion of patterned and large matrices, numerical aspects; Kalman filtering.

**GS 5021 Geodetic Models (2-0-1), pre-req. GS5020, (course exist)**
Conventional celestial and terrestrial references frames, geodetic datum, geoid, ellipsoid of revolution, geodetic coordinates, height systems, 3D geodetic model and modeling observations, reduction of observations, observation equations, partial derivatives, 3D network adjustments, height-controlled 3D networks, GPS vector observations, review of spherical trigonometry and spherical harmonic expansions. Geodesic line on the ellipsoidal surface, geodesic curvature, differential equations of the geodesic, direct and inverse solutions, 2D network adjustment on the ellipsoidal surface, partial derivatives, reduction of observations, traditional horizontal and vertical networks in surveying and geodesy; in-depth review of differential geometry. Conformal mapping of the ellipsoidal surface, meridian convergence, point scale factor; State Plane Coordinate systems, Transverse Mercator, Equatorial Mercator, Lambert Conformal with one or two standard parallels, polar azimuthal, and UTM; reduction of observations, computations on the conformal map and relation to the surface of the earth; review of complex variables.

**GS 5022 Geospatial Positioning (GS-5021), (2-0-1), prereq GS5020 or similar from another University (course exist)**
ITRF and ICRF references frames and transformations, tectonic plate motions, precession, nutation, polar motion, rotational and atomic time scales, GPS time scale, normal orbits, Kepler's laws and equation, topocentric satellite motions, visibility, perturbation of satellite orbits, solar radiation pressure, impact of asymmetry of gravity field and earth's flattening; GPS, GLONASS, Galileo and COMPASS satellite systems. Pseudorange and carrier phase observables, satellite time, relativity, broadcast and precise ephemerides, range iteration, receiver and satellite clock errors; singularities, tropospheric refraction and absorption, impact of the ionosphere, solid earth tides, ocean loading, satellite antenna offset, phase windup correction, closed form solutions; Kalman filter; timing, mapping of the spatial and temporal variation of the troposphere and ionosphere. Differencing observables in space and time, common-mode error reduction, geometry-free solutions, widelaning, cycle slips, constraint solutions, integer ambiguity estimation, LAMBDA, antenna calibration, multipath on pseudoranges and carrier phases, spatial vector networks, differential corrections, global data collection and maintenance, GPS services.

**GS 4050 Cartography and Geographic Information Systems (1-1-1), course is scheduled for delivery in spring 2009 for the current Surveying Engineering Program.**
Cartography and maps; the map as an interface to GIS; Geospatial Data acquisition (methods and techniques; vector and raster data and file characteristics; deriving data from existing maps; control and accuracy in cartographic data). Cartography and the cartographic communication process; Map functions and
map types. Maps and the nature of GIS applications (map scale and GIS applications Geospatial, thematic and temporal comparisons of cartographic data). Mathematical cartography and map projections. Measurements from maps (fundamentals of cartometry); statistical mapping and cartographic generalization. GIS and cartographic mapping: requirements for cartographic component in GIS packages. Desktop mapping, map production and distribution; updating geospatial data. Map making and visualization of spatial data in natural, geo- and social sciences

GS 4010 Geospatial concepts, technologies and data(3-0-0), course is scheduled for delivery in spring 2009 for the current Surveying Engineering Program.
a) Fundamental spatial concepts (Euclidean space, geometry of space, topology of space, network spaces, metric spaces);
b) Geospatial concepts (coordinates, projections and transformations);
c) Fundamental measurement concepts (2D and 3D measurements, errors of measurements and their analysis);
d) Fundamental geomodeling concepts (reducing Earth objects to formal descriptions; the modeling process, objects and fields in geospatial modeling); e) Geospatial source information and media (images, drawings and maps);
f) Geospatial measurements (measuring location, distance, area and volume);
g) Geospatial data collection (statistical and spatial data sampling, resolution, accuracy and scale, data generalization and abstraction);
h) Geospatial data acquisition techniques (measurement and imaging technologies), i) Maps and mapping technologies (land surveying, topographic mapping, aerial surveying and photomapping, cartographic mapping);
i) Geospatial data and metadata formats and visualization (use, storage and distribution, Network and mobile technologies for geospatial data acquisition and use).

MTRI short courses:

GS MTRI-SC5001 Synthetic Aperture Radar short course (1 credit), course exist. Principles and theory of Synthetic Aperture Radar (SAR), applications, and interpretation will be presented. Topics will include review of radar concepts, applications of interferometric SAR (InSAR), types of available satellite and airborne systems, and image processing and interpretation methods. Applications for creating topographic data, recognizing targets, classifying ice and vegetation, and ocean / large lake will be presented based on real-world examples The material will be a combination of lectures and discussions, with one lab.

GS MTRI-SC5002 Infrared Technology, Sensors, and Applications short course (1 credit), course exist. Infrared remote sensing fundamentals, current and future technologies, and applications will be presented. Included topics will review historical applications of infrared technology and their uses and limitations, and compare these to newer tools that are making infrared data collection and interpretation an important component of understanding changing landscapes. Remote sensing for both civilian applications such as environmental resource mapping and military applications will be included. The material will be a combination of lectures and discussions, with one lab.
GS MTRI-SC5003. GIS Technology Fundamentals (1 credit), course exist.
This course will provide a review of the fundamentals of the technology and principles behind Geographic Information Systems applications and analysis. Included will be a review of core concepts such as data acquisition and management, topology, accuracy, metadata, output, quality control, analysis methods, newer and traditional software options, web mapping, and the implementation and management of GIS in research and the workplace. The course attendee will be better placed to use GIS tools effectively in their research and future applications. The material will combine lectures, discussion, and at least two labs.

GS/GMES MTRI Sem-C1: Microwave and Electro-Optics Fundamentals and Applications (3 credits). (Will be developed by Spring 2009)
Electro-optics (visible and infrared) and microwave remote sensing fundamentals, hardware, current and future sensors configurations (ground, aircraft, and satellite), data exploitation and applications will be presented in depth. Course topics include: electromagnetic theory as applied to remote sensing, sensor hardware, remote sensing platforms- present and future, data archives, processing algorithms, exploitation algorithms, and civil and military applications examples. The material will be mostly lectures with limited discussion and one to two labs. A term project with class report out and written paper will also be required.

Requirements: Advance undergraduate or graduate standing. Knowledge of physics and calculus are also strongly recommended.

Note: Final MTRI courses numbers will be assigned after courses processing through MTU binder system.

7.2 PHASE II. INTEGRATED GEOSPATIAL TECHNOLOGY 30 CREDITS PROGRAM.

The following new courses will be developed based on funds availability and students’ enrollments.

GS 5030 Earth observation systems and technologies (3-0-0)
Optical radiation models (electromagnetic spectrum and EM radiation, interaction of EM radiation with atmosphere and surface objects); Sensor models spatial, spectral and temporal resolution; spatial and spectral response; sampling and quantization; geometric and radiometric distortions; topographic and sensor effects); Correction and calibration (sensor and image calibration; geometric image displacement and distortions); Reference surfaces and ground control points (surveying and georeferencing); Image geometric correction: (rectification and orthorectification); Earth imaging technologies (comparative study of terrestrial, aerial and satellite imaging sensors)

GS 5040 Analytical and digital photogrammetry, (2-1-1), prereq SU4140 or similar from another University
Introductory Concepts (Photogrammetric Systems, Photogrammetric applications and products, Sources of Photogrammetric Information, History); Elementary Photogrammetry (Perspective projection, image coordinate system, relief displacement, parallax and stereo, image overlap, epipolar Planes and lines);
Photogrammetric Sensing Systems (Physics of remote sensing – electromagnetic energy, optics, sensing, image quality, imaging geometries, image motion compensation, frame camera, camera calibration, active sensors, platforms for photogrammetric Sensing); Mathematical Concepts in Photogrammetry (Perspective geometry, sensor modeling in aerial and satellite imagery); Resection, Intersection, and Triangulation (Single photo-projection, relative and absolute orientation, block triangulation and adjustment, self-calibration, evaluation of block adjustment); Digital Photogrammetry (Digital imagery and digital image processing, image resampling, image compression, digital image measurement, computer vision and computer graphics); Photogrammetric Instruments); Hardcopy and softcopy based systems; Photogrammetric Products (Hardcopy and digital photogrammetric products, GIS, 3D photogrammetric products, products accuracy and quality assurance); Close-Range Photogrammetry (Instruments and software for close-range photogrammetry, mathematical models for close-range photogrammetry, calibration procedures, applications of close-range photogrammetry); Analysis of Multispectral and Hyperspectral Image Data (Statistical pattern recognition and classification, feature reduction and spectral transformation, multiSpectral Data); Active Sensing Systems (Radar imaging fundamentals, the radar equation, SAR processing and geometry model, introduction to IFSAR, LIDAR.).

**GS 5041 Advanced photogrammetry and applications,** (1-1-1), prereq GS5040
Procedures for large-area point measurement (Block adjustment of independent models, bundle block adjustment, satellite positioning for point determination, aerial triangulation with GPS support, effects of earth’s shape and the distortions of national coordinate systems); Special Features of Digital Photogrammetry (Automatic fiducial marks location, measuring image coordinates of natural features, Special features in relative orientation, and special features in aerial triangulation); Quality control and detection of errors (Accuracy control (inner, relative, absolute, block), least-squares adjustment with and without random errors, data snooping, robust procedures, reliability checks for photogrammetric standard procedures, variances estimations for observation groups); Photogrammetric Engineering Applications with cases study: Large scale aerial triangulation, Photogrammetric Cadastral Surveys, Buildings Reconstruction from non-metric images, Forensic photogrammetry. Photogrammetric Measurement and Visualization of Surfaces (Digital orthophotos, digital stereoothophotos, surface visualization by means of digital orthophotos, 3D photomodels, automatic definition of object Surfaces); Photogrammetric capture and visualization of Dynamic Phenomena (Motography with photographic cameras, the spatio-temporal system, visualizing phenomena and dynamically visualizing static objects); Calibration of Photogrammetric systems (Concepts of calibration, calibration procedures, calibration of various types of camera).

**7.3 PHASE III (OPTIONAL) DEVELOPMENT OF ADDITIONAL GEOSPATIAL COURSES**

**GS 5051 Cartographic modeling and Geospatial Data Visualization ,** (1-1-1)
Cartographic visualization (presenting geospatial data); graphic variables (location, value, hue, size, shape, spacing and orientation); geospatial data (perceptual and cognitive limitation); geospatial data (Graphic and display limits); representing geospatial data uncertainty and temporal dependence; visualization of
multidimensional data on 2-dimensional displays designing maps and multimedia cartographic products; visual information and multimedia techniques (internet, web and digital media) multimedia cartography (geospatial data and hypermaps); cartographic design and implementation strategies for cyber-cartography; internet GIS and web-mapping technologies; geography markup language

**GS 5032 Geospatial image analysis and interpretation (0-2-1)**
Image informative properties (content, resolutions, generalization and scale
Visual information: quantitative and qualitative approaches; measuring of information); Image media (photographic and digital presentation); Visual image interpretation (image interpretation keys); Image information extraction (indices and objects); Computer-assisted image analysis (pixel-based and object-based approaches) Pixel-based classification (approaches to multispectral image classification) Object-based classification (feature extraction approaches); Accuracy of image analysis and interpretation; Trends in image and visual data mining.

**GS 5031 Digital processing of geospatial imagery (1-2-1)**
Data models (photographic and digital imagery; photo digitalization; sampling and quantization; image presentation in digital form; univariable image statistics, statistical measures of image quality); Spectral and spatial transforms (image enhancement; convolution and filtering; Fourier transforms; scale-space transforms and rectification); Image correction and enhancement (sensor and image radiometric calibration; noise reduction, atmospheric correction); Geospatial imagery data: presentation, compression, storage and distribution

**GS 5033 Algorithms and programming in applied geospatial image analysis(1-2-1)**
Images, arrays, and matrices (Algebra of vectors and matrices, eigenvalues and eigenvectors, vector derivatives, image statistics, parameter estimation, hypothesis testing and sample distribution functions, Bayes' Theorem and classification, Ordinary linear regression); Transformations (The discrete Fourier and wavelet transforms, principal components, Maximum noise fraction, spatial correlation, convolutions, filters, and fields, linear filters, wavelets and filter banks, Gibbs-Markov random fields); Image Enhancement and Correction (Lookup tables and histogram functions, High-pass spatial filtering, panchromatic sharpening, Topographic correction, Image-image registration); Supervised Classification (Maximum a posteriori probability, training data and separability, maximum likelihood classification, Gaussian kernel classification, Neural networks, postprocessing, evaluation and comparison of classification accuracy, hyperspectral analysis); Unsupervised Classification (Simple cost functions, fuzzy maximum likelihood estimation clustering, including spatial information, the Kohonen self-organizing map); Change Detection (Algebraic methods, principal components, post-classification comparison, multivariate alteration detection, decision thresholds and unsupervised classification of changes)

**GS 4060 Advanced geospatial technologies and applications (3-0-0)**
Advanced geoimaging technologies (Aerial and terrestrial lidars for surveying and industrial applications; UAV and robotics imaging systems; non-topographic and
close-range photogrammetry; videogrammetry; surveying and photogrammetry for homeland security, surveillance and military applications; augmented geoinformation systems and technologies; wireless, internet and mobile mapping and geospatial technologies; geospatial data compilation, conflation and updating; distributive and corporative data networks; security, legal and copyright issues in geospatial data. Geospatial data visualization (visual modeling and data presentation, spatio-temporal immersive visualization, autostereoscopic 3D vision, tactile data sensing and management (touchtable, datawalls etc); current trends in global navigation satellite systems; emerging trends in advanced surveying technologies.

**GS 5061 Special Topics in Integrated Geospatial Technologies (0-2-1)**
Specific topics individually tailored to the students expressing a specific interest and having access to particular technologies, instruments and data, which are not available at MTU. MTRI will be involved heavily in this course development and delivery.

**GS 4200 Advanced geospatial practicum** (0-2-1), prereq GS4010
Advanced study and extensive practical training in modern software packages according to student’s specialization. The student should take training in at least two software packages from the following list (software packages is subject of availability):
- a) Carlson Software (surveying)
- b) Trimble Geomatics Pathfinder Office (GPS and data adjustment)
- c) ENVI/Definiens eCognition (geospatial image analysis and recognition)
- d) ArcGIS/MapInfo/GRASS (generic GIS and cartography software)
- e) VrMapping, StereoGIS, Photomodeller (softcopy photogrammetry)
- f) PCI Geomatica/ERMapper (geospatial data software suites)
- g) Skyline TerraBuilder, TerraExplorer (3D visualization of geospatial data, cybercartography)

**GS 5200 Engineering Report (3 credits)**
Course work study on engineering subjects within selected specialization stream. Designed for Masters of Engineering degree (option C).

**GS 5310 Advanced Engineering Practicum (6 credits)**
Advanced senior engineering practicum in industry or government on engineering subjects within selected specialization stream. Required comprehensive report. Designed for Masters of Engineering degree (option D).

**GS 5500 Graduate Research (6 credits)**
Supervised research in selected specialization stream conducted in partial fulfillment of the requirements for MAppSc degree according to the student’s tailored Masters of Applied Science degree plan (options A & B).

### 8. Library and other learning resources.

The library has basic literature in area of geospatial technologies, but it is anticipated that the program will require some extra funds to update and extend existing resources.
9. **Computing Access Fee.**

Initially each student will pay the Computing Access Fee to general computer lab in the School according to the department’s policy. Eventually, with establishing of the Center for Integrated Geospatial Technologies and dedicated Geospatial Laboratory, the program may have its own fee.

10. **Faculty resumes (a web site link is sufficient).**

Eugene Levin, PhD ([http://www.tech.mtu.edu/Faculty_Pages/Eugene_Levin.html](http://www.tech.mtu.edu/Faculty_Pages/Eugene_Levin.html))

Robert A. Schuchman, Ph.D ([shuchman@mtu.edu](mailto:shuchman@mtu.edu))

Robert Liimakka, MSc, PhD candidate (ABD) ([http://www.tech.mtu.edu/Faculty_Pages/Rob_Liimakka.htm](http://www.tech.mtu.edu/Faculty_Pages/Rob_Liimakka.htm))

Alfred Leick, PhD ([www.gnss.umaine.edu](http://www.gnss.umaine.edu))

Gennady Gienko, PhD ([http://www.geo.fio.usp.ac.fj](http://www.geo.fio.usp.ac.fj))

The MTU Geospatial Initiative anticipates that the faculty will be expanded by secured strategy minimizing risks by means of sustainable and self-support coursework development and new faculty lines opening based on enrollments in fact. Besides that Initiative match MTU strategic plan therefore in the future other faculty expansion and development programs may support the growth of program.

11. **Description of available/needed equipment.**

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
- Carlson Civil Suite software (90 licenses) $927,000
- SimWright StereoGIS softcopy photogrammetric workstation (5 licenses) $50,000
- Cardinal Systems VrMapping photogrammetric software suite (12 licenses) $120,000
- Chevrolet PT Cruiser vehicle worth $6,700

Total current assets are valued in **$1,699,700.**

Surveying and GPS component of the Masters program is currently covered with sufficient equipment and software. The photogrammetric component will require purchasing dedicated high-end workstations for stereoscopic image analysis and
measurements (5 PC). The image analysis and cartographic component will require
dedicated cartographic and geovisualization software.

A Minimal Risk Phase I and Phase II (30 credits) program can be delivered without
additional investments of the equipment.

Optional Phase III (51 credits) program development and course delivery will require
purchasing the following equipment:

- 5 High-end dual-processor photogrammetric workstations with stereoscopic
  screens and shutter-glasses ($10,000)
- Geo Server
- 1Gbit local network
- 15 dual screen PCs
- A0 plotter
- A3 flat bed scanner
- laser color printer
- overhead projector
- computer lab furniture

12. Program costs for Phases I, II and III. (Additional information may be
requested by the Senate Finance Committee.)

The MTU Geospatial Initiative anticipates as a safe strategy that the new faculty lines
will be opened simultaneously with the enrollments to the program growth in fact.
Besides we expect that new faculty will develop and teach both graduate and
undergraduate courses. In addition the extramural research funding generated by the
current and expected new faculty members will help in providing a sustainable
development of the program.

The risk mitigation strategy with projected rollout and start-up costs calculation are
given in section 17 of the current proposal.

Positive acceptance of MTU Geospatial Initiative by the MTU administration,
departments of Socials Sciences, Geology, Forestry, Cognitive Sciences, Electrical
Engineering, MTRI makes us confident that over the next years one of the
Sustainable Development strategic plans will be dedicated to Geospatial
technologies. This fact may accelerate the program development significantly,
however we believe in the successful program development based on only the
School of Technology internal resources and external grants as described in section
2.

13. Space.

The Geospatial Technologies program requires establishing dedicated teaching
laboratory and office space for graduate students and new faculty.

- Geospatial Laboratory (to accommodate 15 dual screen PCs, 5
  Photogrammetric Workstations, 1 Server, A0 plotter, A3 scanner and 6
cartographic workbenches): 800 sq ft (approx)
Surveying and Geodetic Laboratory (winter lab classes) next to the Surveying equipment storage room: 450 sq ft + 150 sq ft (approx)

Office space:

- for new faculty: 3 offices 100 sq ft each (when faculty lines will be secured by enrollments and grants)
- for graduate students: 5 offices 100 sq ft each (shared between 10 students)


Not applicable.

15. Accreditation requirements.

Not applicable.

16. Internal status of the proposal.

Approved by:

17. Risks mitigation strategy, rollout plan and start-up cost calculation

Understanding the complexity of risks for Michigan Tech related to the implementation of the proposed graduate program, the School of Technology proposes the following risk mitigation strategy:

- The program start with minimal faculty lines openings based on a minimal 30 credits rollout plan;
- To secure investments we propose that the current Surveying Engineering program and the Certificate in Integrated Geospatial Technology, will be supported by the same 4000 level courses and will be given by the same faculties, start at the same time;
- Most of the proposed courses with differing lab workload for 5000 and 3000 level courses, will be used in the current Surveying Engineering and new Geospatial Engineering undergraduate degrees
- The development of the optional 51 credits coursework (Phase III) will be secured after a successful 30-credit (Phase I and Phase II) period marketing strategy and by extramural research funding obtained by current and new-hired faculties
- The Interdisciplinary Research Center/Institute for Geospatial Technology’s unique combination of education and research can be considered as another factor minimizing risks in the program strategy. An NSF IGERT geospatial proposal, together with IIS, MTRI and multiple MTU schools establishing this Institute organizationally has already been submitted.

The preliminary calculation of the start-up rollout plan is presented in Table 2. The calculation assumes a tuition of $545 and $300 per graduate and undergraduate course credit respectively. For simplicity of calculation it is assumed that all courses are
being offered on an annual basis for both the graduate and undergraduate degrees. The start-up cost calculation includes the fully loaded cost of a faculty member of $110,000 per year. It follows from Table 2 that in order to cover the opening of 2 new faculty lines, which are necessary (for deliver only - the course development will be covered by overhead and will be done off-line) for the Phase II 30 credits program implementation. An alternative to faculty line openings can be online courses from other Universities. However, this learning-brokerage solution which is very cost-efficient will not develop the learning-and-research atmosphere that is center to this proposal. An enrollment of 139 students in the undergrad programs and 10 students in the proposed graduate program is needed. The current surveying engineering enrollments exceed 50 students; therefore an additional increase of 89 students in connection with the new Geospatial Engineering undergrad program seems to be a realistic goal. We already have 5 students willing to start graduate education in the fall of 2008. Ten graduate students will make the proposed program a “zero profit”. Two faculty lines are secured by the new undergrad program. With 7% of the undergrad students deciding to rollout into the proposed graduate level program will create a self-sufficient situation.

The start-up cost calculation given above is certainly preliminary and it models numerically the “worst of the worst” situation when none of research funds will be delivered by the geospatial faculties. Relying on an average MTU proposals winning rate of 67% we are confident that real-life situation will be more favorable for the program. It assumes that new-hired faculties will submit and win research grants that support graduate students. For example, if all the faculties mentioned above will deliver $100,000 research funding per year the proposed graduate program can become almost independent from undergraduate tuition financially. This is our view of sustainable development of geospatial research and education in Michigan Tech. We believe that extramural research funds and the program’s national and international expansion strategy described in section 4 will make it profitable for Michigan Tech.

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<td>-138250</td>
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<td>cost balance for both programs $, total</td>
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Graduate Certificate

CERTIFICATE IN ADVANCED GEOGRAPHIC INFORMATION SYSTEMS

Introduction

This proposal recommends establishing a graduate certificate entitled “Certificate in Advanced Geographic Information Systems.” Courses contributing to this certificate are currently offered by the School of Forest Resources and Environmental Science, School of Technology (Surveying Engineering), the Department of Geological and Mining Engineering and Sciences and the Department of Mathematical Sciences. Students completing this certificate will have established a set of core competencies in geographic information systems and have developed an advanced understanding of the application of geographic information systems (GIS) in their field of expertise. The program will be open to all students who have completed a Bachelor’s Degree.

I. Title of Certificate
Certificate in Advanced Geographic Information Systems

II. Catalog Description
A Certificate in Advanced Geographic Information Systems provides the student with the in-depth knowledge needed to understand and work with geographic information systems and spatial data in a broad range of applications such as natural resource management, environmental and civil engineering, natural hazards mapping, geology and geological engineering, industrial archeology and social sciences, to name a few.

III. Rationale
The US Department of Labor has predicted that jobs utilizing geographic information systems technology in various fields will increase by 20% by 2015. Currently, there is a shortage of qualified personnel to fill these open positions, particularly those with advanced training and a strong quantitative background. Furthermore, the worldwide market for geographic information systems technologies has enormous potential. Estimated at $5 billion in 2001, the market is expected to have annual revenues of $70 Billion by 2015.

This Certificate program is designed, in consultation with employers both government and private, to train students in the theory, knowledge and advanced use of GIS and its utilization in a wide range of applications.

IV. List of Courses (Total Credits-- 19 or more)
Required Courses (13 Credits)

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>FW5550</td>
<td>Geographic Information Systems for Resource Management (4 credits)</td>
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<td>FW4540</td>
<td>Remote Sensing of the Environment (3 credits)</td>
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<tr>
<td>GE4250</td>
<td>Fundamentals of Remote Sensing (3 credits)</td>
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<tr>
<td>FW4551</td>
<td>Digital Cartography and Mapping (3 credits)--being proposed</td>
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<tr>
<td>MA4710</td>
<td>Regression Analysis (3 credits)</td>
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</table>
MA 4720  Design and Analysis of Experiments (3 credits)
OR
FW5411  Applied Regression Analysis (3 credits)

Elective Courses (6 or more Credits)
FW4170  GPS Field Techniques (1 credit) - currently taught as a special topics course
FW5540  Advanced Terrestrial Remote Sensing (4 credits)
FW5560  Digital Image Processing: A Remote Sensing Perspective (4 credits)
FW5510  Special Topics in Natural Resources (variable credits)
GE4150  Natural Hazards (3 credits)
GE5250  Advanced Computational Geosciences (3 credits)
SU4140  Photogrammetry (3 credits)
MA4750  Applied Multivariate Statistics (3 credits)
MA5740  Advanced Sampling Methods (4 credits)
MA5791  Categorical Data Analysis (3 credits)

V. New Course Descriptions
All courses except FW4170 and FW4551 are currently being taught. FW4170 is a new course and will be taught for the first time this summer as a Special Topics. This course and FW4551 are being developed with internal resources in the School of Forest Resources and Environmental Science and will enter the binder process in the fall of 2008.

FW4551 Course Description
Cartography is the art and science of map making. In this course, the map-making process, map projections, finding and compiling spatial data, typography, map symbols, map design, color choice, and map production are covered in a GIS context. The map as a method of communication is emphasized. Raster and vector GIS data are used. Ethical issues involved in the map-making process are addressed. You will learn principles for creating appealing maps that effectively communicate information to your audience. By the end of the semester you should be able to produce maps for presentations, theses, reports, web pages, or journal articles.

VI. Library and other Learning Resources
No new library resources will be needed for this certificate.

VII. Computing Access Fee
Students enrolled in this Certificate will be charged the same fees and follow the same policies as those for their home department. If the student is a non-degree student, the fees and policies for the School of Forest Resources and Environmental Science will be followed.

VIII. Faculty Resumes
(see attached) Ann Maclean, Eugene Levin

IX. Needed Equipment
No special equipment is needed for this program
X. Program Costs
No additional costs anticipated

XI. Space
No additional space is needed

XII. Policies, Regulations and Rules
There will be no additional policies, regulations, or rules for this program beyond those existing for graduate certificates, except all coursework counted towards the certificate must be completed with a grade of “B” or better.

The certificate will be administered by the School of Forest Resources and Environmental Science.

XIII. Accreditation Requirements
None

XIV. Internal Status of the Proposal
Approved by the faculty/dean/dept head of the School of Forest Resources and Environmental Science, Department of Geological and Mining Engineering and Sciences, and the School of Technology

XV. Planned Implementation Date
As soon as approved.
Ann L. Maclean  
Associate Professor  

School of Forest Resources and Environmental Science  
Michigan Technological University  
1400 Townsend Drive  
Houghton, MI  49931-1295  
(906)487-2030  
amaclean@mtu.edu  

Education  
M.S. Forestry, University of Wisconsin, Madison, Wisconsin, 1984.  
B.S. Forestry, Michigan Technological University, Houghton, Michigan, 1976.  

Employment  
Associate Professor (1993 - present), Remote Sensing/Geographic Information Systems, School of Forestry and Wood Products, Michigan Technological University, Houghton, Michigan, 49931.  
Assistant Professor (1986-1993), Remote Sensing/Geographic Information Systems, School of Forestry and Wood Products, Michigan Technological University, Houghton, Michigan, 49931.  
NASA Trainee (1983 to 1986), Goddard Space Flight Center, Greenbelt, Maryland.  

Peer-Reviewed Publications  


**Book Chapters**


**Video Produced**

Maclean, A and T. DeBruyn. 1999. Education Video of Black Bears for Primary Grade School Children.

**Publications Edited**


Peer-Reviewed Report

Non-Referred Publications


**Externally Funded Research**


Ann L. Maclean


Professional Memberships
American Society for Photogrammetry and Remote Sensing
Past Associate Editor for *Photogrammetric Engineering and Remote Sensing* (1997-1999)
Past Director of the Geographic Information Systems Division (1995-97)
Past Chair of the Education Committee (1993-1995)
Past Chair- Space Imaging Digital Imagery Award
Current Manuscript Reviewer
Eugene Levin
Assistant Professor

School of Technology, Surveying Engineering
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295
(906)487-2446
elevin@mtu.edu

Education

Ph.D. Photogrammetry, State Land Organization University, Moscow, Russia 1989
M.S. Astro-Geodesy, Academy of Engineers in Geodesy, Aerospace, Survey, and Mapping, Novosibirsk, Russia, 1982

Professional Experience

MICHIGAN TECHNOLOGICAL UNIVERSITY, Houghton, Michigan 2007 – present
Assistant Professor, Graduate Program Development Coordinator

Work on MTU Geospatial Initiative encompassing new undergraduate two Master and one Ph.D degrees along with development of Integrated Geospatial Technology Research Center.

► Teaching 4000 level courses:
  SU4140 Photogrammetry
  SU4100 Geodetic Positioning
► Teaching 3000 level courses:
  Lab for FW3540 GIS course

Development of the new 5000/6000 level courses for new degrees: BS Geospatial Technology and MS/PhD in Integrated Geospatial Technology.

► Member of Ph.D committees.
► Work on publications and Research Grants submission

AMERICAN GNC, Simi Valley, California 2006 – 2007
Program Manager

Responsible for the design and development of products in the fields of UAV-based moving target surveillance and tracking, image processing, automation in photogrammetry and remote sensing, mapping, GIS, LIS, robotics, navigation, guidance and control, integrated navigation systems, embedded software, modeling and simulation.

► Developed 4D GIS system for moving targets tracking, prediction and visualization. Performed system demonstration at Armament Research and Development Engineering Center (ARDEC). System encompasses UAV image processing, computer vision, geospatial reasoning and efficient 3D visualization.
Oversaw development of Web-based Remote Sensing technology within NASA Stennis center research program. System integrates multi-tier client server architecture and advanced neural network based hyperspectral satellite image processing algorithms.

Developed algorithms for man-made terrain features extraction from oblique aerial and terrestrial imagery.

Work with outsourcing development team in Taiwan.

FUTURE CONCEPTS, La Verne, California 2005 – 2007

GIS Manager

- Developed architecture for the mobile Incident Command Center multi-tier GIS technology
- Supervised GIS development in-house and in overseas.

DIGITAL MAP PRODUCTS, Costa Mesa, California 2005 – 2006

Lead Photogrammetrist

Consulted with Marketing and Business development on scope, feasibility and requirements. Actively promotes creativity and open discussion throughout the organization. Assisted in creating company culture that respects diversity and differences of opinions.

- Involved in work with software engineering team members to design and development of object oriented systems that use and enhance Digital Map Products API, using C++, Java, JavaScript, HTML, XML, XSLT.
- Integrated real-time fleet management (GPS/RFID/GPRS) functionality into Web-GIS services.
- Technically directed team efforts. Research and adaptation of the new tools, languages and techniques
- Prepared SBIR and BAA proposals for NASA, DoD and Homeland Security federal government agencies.
- Oversaw aerial and satellite imagery data workflows in LandVision and CityGIS products.

PHYSICAL OPTICS CORPORATION, Torrance, California 2000 – 2005

Senior Scientist / Team Leader Geospatial Technology

Principal Investigator and Project Manager on several award-winning government programs. Heavy involvement in several POC government contracts (automatic target recognition, photogrammetry, and mapping). Software development outsourcing in Russia. Prepare scientific proposals for USAF, NGA, NASA, and NSF.

- Developed a new approach of target-recognition based on fusion of photogrammetry and catastrophe-theory image processing.
- Designed a proposal-level system for automated change detection. Developed algorithms and technology for flight-simulation database generation based on aerial and satellite imagery.
- Created multi-level frame technology for DTED generation based on exploration of Russian satellite imagery for NGA.

Eugene Levin

NESS TECHNOLOGIES, Tel-Aviv, Israel 1996 – 2000
Chief Photogrammetry Analyst

Served as a key member of the Military Photogrammetric Intelligence system development team. Oversaw algorithm and software development for a large defense project. Developed algorithms of geometrical solutions for non-standard photos (oblique, panoramic, CCD and other sensors), including customization for stereo-visualization on Intergraph stations and GIS applications for analytical Phototriangulation.

► Developed airfield ground traffic control (AGTC) GIS application for military/civilian airport uses.
► Introduced algorithms and applications to BEZEQ (Telephone company of Israel) based on MicroStation GIS for graphical representation of wave propagation modeling.
► Developed technologies on automated quality assurance for GIS based projects.
► Completed a training course on processing of Russian satellite images (SOVINFORMSPUTNIK Company, Tel-Aviv, Israel, 1998).

FEDERAL CADAstral CENTER “LAND”, SIBERIAN BRUNCH, Omsk, Russia 1992 – 1995
Manager – Department of Land Registration and GIS

Managed a group specialized in software development of topographic and cadastral data digital processing. Introduced technological lines of air photos and image processing for Land Registration. Coordinated group’s legal issues (including merchandising contracts, employment terms, loan agreements, and real estate purchases).

► Located equipment suppliers throughout Europe and USA, and carried out technical and financial analysis of tenders. Conducted negotiations and concluded project planning.

OMSK AGRICULTURAL ACADEMY, Omsk, Russia 1989 – 1995
Lecturer / Senior Lecturer / Associate Professor

Created lectures and practical courses in GIS Image Processing and Basic of Remote Sensing for post-graduate students specialized in Land Organization and Geodesy. Created software to support practical course in Digital Image Processing

► Instructed a training course and summer field practice in Image Interpretation for Topographic Mapping.
► Supervised graduate students on diploma projects. Consulted Ph.D. thesis students on research investigations of scientific opponents.

RESERcH INSTITUTE OF APPLIED GEODESY, NOVosibirsk, Russia 1982 – 1985
Software Engineer

Designed low-level API for data obtaining field systems, including adjustment computations. Developed algorithms and applications for online generation of DTM-based on-field surveying systems. Introduced products for gravimetric measurement automation.

Eugene Levin

Selected Publications
A “SIGHT-SPEED” HUMAN-COMPUTER INTERACTION FOR AUGMENTED
GEOSPATIAL DATA ACQUISITION AND PROCESSING SYSTEMS, In: Stilla U et al
(Eds) PIA07. International Archives of Photogrammetry, Remote Sensing and Spatial

HUMAN CENTRIC APPROACH FOR GEOSPATIAL DATA FUSION IN HOMELAND
DEFENCE AND SECURITY APPLICATION SCENARIOUS, accepted by SPIE Defense
and Security Symposium, E Levin, G Gienko, A Sergeev. , submitted to SPIE Defense and
Security Symposium, Orlando, FL , March 2008

Eye movement analysis in visual inspection of geospatial data, (E Levin, G Gienko)

EYE-TRACKING FOR STEREOSCOPIC GEOSPATIAL IMAGE ANALYSIS (Alex
Sergeev, Eugene Levin, Gennady Gienko), submitted to XXI congress of ISPRS, Beijing
China, July 2008

Geometric approach to multisensor, multiresolution image fusionProceedings of ASPRS
Annual Conference , Baltimore 2005 (E. Levin, G. Guienko)

Development of Analytical Photogrammetric Networks Based on Russian Satellite Imagery
Proceedings of ASPRS Annual Conference ,Denver 2004 (E. Levin, P.Salamonowiz, G.
Gienko, V Chekalin)


Open source data to improve geometric accuracy of IKONOS Geo images
Proceedings of ASPRS Annual Conference, Anchorage 2003 (E. Levin, G. Guienko)

Geographic information to support vision-based approaches for GPS-independent
autonomous navigation
Proceedings of ASPRS Annual Conference, Anchorage 2003 (E. Levin, G. Guienko, A.
Zhranovksy)

Multilevel frame method for phototriangulation and digital elevation model generation
Proceedings of ASPRS Annual Conference, Anchorage 2003 (E. Levin, V. Chekalin)

Flexible simulation strategy for modeling 3D-cultural objects using multi-source remotely

Eugene Levin

Catastrophic approach to satellite imagery utilization on network-based flight simulators

Eye-tracking in Augmented Photogrammetric Technologies
Proceedings of ASPRS Annual Conference, Baltimore 2005 (G. Guienko, E. Levin)

Aspects of satellite imagery exploration in GIS-based command and control real-time technologies

GIS-based UAV real-time path planning and navigation

Externally Funded Research

**USAF:** Analytical Manifold Modeling for Dynamic Planning and Execution.
*PhaseI,* F30602-01-C-0117, 04/01/01-01/01/02, ~$99,992
*PhaseII,* F30602-02-C-0132, 09/25/02-09/24/04, ~$744,280, Principal Investigator and Project Manager

**NAVY:** Look-Measure Analyze Toolset for Image processing and GIS
*PhaseI,* N00039-020-C-2203, 05/30/02-11/30/02, ~$99,992, Principal Investigator and Project Manager.

**NGA (former NIMA):** Multi-level Frame Technology for Digital Elevation Data Generation.
*PhaseI,* NMA401-02-C-0005, 04/11/02-10/11/02, ~$99,976
*PhaseII,* NMA501-03-C-0011, 09/25/03-09/24/05, ~$499,973, Principal Investigator and Project Manager

*PhaseI,* NBCHC050111, 06/01/05-12/01/05, ~$99,999

**US Army:** 4D GIS-based Virtual Reality for Moving Target Prediction and Visualization
*PhaseI,* W1SQKN-06-C-0014, 01/05/06-6/05/06, ~$99,999, Project Manager.
*PhaseII,* W1SQKN-06-C-0202, 08/30/06-08/30/08, ~$729,952, Principal Investigator and Project Manager.

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Eugene Levin

Research Interests

- Sensors. Methods of high-resolution remote sensing.
- Image-processing. Automated feature extraction from aerial and satellite imagery.
- Remote sensing and GIS: data fusion.
- GIS-oriented image analysis.
Spatio-temporal datamining
Knowledge Extraction
Autonomous GPS-independent navigation.
Photogrammetry of aerial and high-resolution satellite imagery.
Digital image processing and GIS in applied geosciences.
Remote sensing and environmental engineering.

Professional Memberships
  American Society for Photogrammetry and Remote Sensing (ASPRS)
  The International Society for Optical Engineering (SPIE)
  Member of Editorial Board of the “GPS Solutions” journal published by Springer-Verlag, Heidelberg, Germany