<u>GEORGIA DOT RESEARCH PROJECT 18-10</u>

FINAL REPORT

Meeting the 21st Century Surveying–Geomatics Education Needs of GDOT and Georgia

Georgia Department of Transportation

OFFICE OF PERFORMANCE-BASED MANAGEMENT AND RESEARCH

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This research project establishes ways to serve the surveying–geomatics (S-G) education needs of place-bound students, such as Georgia Department of Transportation (GDOT) personnel and others. It addresses the need for personnel with a 21st century education (knowledge and skills) in surveying–geomatics. Many factors, including lack of traditional student interest, lack of student preparedness, retirement-replacement issues, ever expanding technology and education materials, and post-recession demand, have forced the Georgia S–G community to recognize the need for an alternative approach to surveying–geomatics education.

Thus, this study proposes a viable solution to the lack of S–G education availability and focuses on ways to foster Professional Land Surveyor (PLS) licensure, as well as improvements in salary and benefits for educated/licensed surveyors. The study also included the administration of a detailed survey based on matrix analysis of S-G knowledge/skill expectations, S-G position characterization, and S-G education subject area coverage. The results of the survey were analyzed to support the understanding of the breadth and depth of the 21st century S–G education among the Georgia S–G community.

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GDOT Research Project 18-10

Final Report

MEETING THE 21ST CENTURY SURVEYING–GEOMATICS EDUCATION NEEDS OF GDOT AND GEORGIA

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June 2021

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ABBREVIATIONS

A/E	Architectural and Engineering
AAG	Association of American Geographers
ABET	Accreditation Board for Engineering and Technology
ABM	Accelerated Bachelor’s Master’s
ACLS	Association of Canada Lands Surveyors
ANSAC	Applied and Natural Science Accreditation Commission
AOLS	Association of Ontario Land Surveyors
ASCE	American Society of Civil Engineers
ATC	Albany Technical College
BORPELS	Board of Registration for Professional Engineers and Land Surveyors
CAD	Computer Aided Design
Caltrans	California Department of Transportation
CBEPS	Canadian Board of Examiners for Professional Surveyors
EAC	Engineering Accreditation Commission
EIT	Engineer in Training
FGS	Foundation Geomatics Surveying
FS Exam	Fundamentals of Surveying
GBORPELS	Georgia Board of Registration for Professional Engineers and Land Surveyors
GDOT	Georgia Department of Transportation
GIS	Geographical Information Systems
GISP	Geographical Information Systems Professional
GPS	Global Positioning Systems
GSU	Georgia Southern University
IRB	Institutional Research Board
IT	Information Technology
ITRF	International Terrestrial Reference Frames
KSU	Kennesaw State University

LiDAR	Light Detection and Ranging
LSIT	Land Surveyor in Training (also known as Survey Intern (SI))
NCEES	National Council of Examiners for Engineering and Surveying
NGS	National Geodetic Survey
NPS	National Park Service
NSPS	National Society of Professional Surveyors
OAGQ	Ordre des Arpenteurs-Géomètres du Québec
PE	Professional Engineer
PLS	Professional Land Surveyor
PPP	Public–Private Partnership
PS	Professional Surveyor
PS Exam	Principles and Practice in Surveying
PTA	Professional Training Agreement
S-G	Surveying–Geomatics
SACS	Southern Association of Colleges and Schools
SaGIS	Surveying and Geospatial Information Science
SAMSEF	Surveying and Mapping Society of Georgia, Education Foundation
SAMSOG	Surveying and Mapping Society of Georgia
SBoK	Surveying Body of Knowledge
SOC	Standard Occupational Classification Code
SPC	Survey Party Chief
TCSG	Technical College System of Georgia
UCGIS	University Consortium of Geographic Information Science
UNG	University of North Georgia

EXECUTIVE SUMMARY

THREE SURVEYING-GEOMATICS MATRICES

In this research project, three surveying–geomatics (S-G) matrices—knowledge and skills, employment positions, and education/subject coverage—were developed. All three matrices were successfully validated by personnel at the Georgia Department of Transportation (GDOT). The following results are summarized from the survey, which was successfully generated from the three matrices.

S-G Survey: Knowledge and Skills

- For positioning, with respect to the importance to S-G operation, the results were consistent with optimizing the S-G process for creating usable surveying information, whether terrestrial or satellite-based.
- For positioning, with regard to importance for new Land Surveyor-in-Training (LSIT)/graduate skills, the results were consistent with optimizing the S-G process for creating usable surveying information, whether terrestrial or satellite-based.
- For geospatial science, with respect to the importance to S-G operation, the analysis reflected how geospatial science is most practiced by the respondents. Nearly all S-G personnel have some use of geospatial data, while fewer S-G personnel might perform analytical methods or data modeling.
- For geospatial science, with respect to weakness ranking for new LSIT/graduate skills, the results reflect a lack of experience for new graduates, which should change over time.

- For imaging science, for significant importance for daily S-G operation, the survey participation was extremely low, which may indicate the respondents' lack of knowledge and experience in this area.
- For imaging science, with respect to weakness ranking for new LSIT/graduate skills, the survey participation was extremely low, which may indicate the respondents' lack of knowledge and experience in this area.
- For land stewardship, with respect to significant importance for daily S-G operation, the analysis was consistent with optimizing the S-G process for operation of an S-G business.
- For land stewardship, with regard to significant importance for new LSIT/graduate skills, the ranking reflects a lack of experience for new graduates, which should change over time.
- For legal aspects, with respect to significant importance for daily S-G operation, the analysis was consistent with optimizing the S-G process for operation of an S-G business.

Results of S-G Survey: Surveying–Geomatics Employment Positions

- The results of the survey indicate that when surveyors are licensed, they tend to receive more salary/benefits.
- A bachelor's degree in S-G or a related field was shown to be the most prevalent education level.
- Boundary surveying, State surveying laws, and land management were viewed as important as geospatial skills (e.g., GIS, LiDAR, etc.) for all surveyors.
- Hiring of surveying personnel should not be handled entirely by the human resources department.
- More S-G program curriculum to support modern S-G employment should be provided.

Results of S-G Survey: Surveying–Geomatics Subject Area/Education Status/Needs

- The bachelor of science degree in S-G or a related field provides the best pathway to become a Professional Land Surveyor (PLS). However, other pathways must be available.
- The evaluation shows that the new S-G employees are good at the S-G fundamental knowledge areas but lack in other areas.
- The S-G professional thinks that the S1 to S5+ courses prescribed by the Georgia Board of Registration for Professional Engineers and Land Surveyors (BORPELS) are good for S-G fundamentals.
- Face-to-face course presentation was ranked as good for knowledge sharing and assimilation, problem-based learning, and presentation.
- The hybrid class system was also acceptable, as this method has the advantages of face-to-face instruction along with time flexibility.
- The online class seemed unpopular, yet this method represents a good method of presentation for distance learning.
- Based on overall skills in graduates, and qualified/experienced S-G instructors, the Georgia S-G institutions were ranked to investigate for future improvements.

Surveying–Geomatics Program: Georgia Southern University (GSU)—A Case Study

- The presentation of the newly defined GSU S-G program provides timely S-G education information for the prospective S-G student.
- Offering multiple S-G program pathways (i.e., non-traditional, undergraduate, and graduate) at GSU optimizes the number of future students.

- The GSU S-G equipment and faculty are acceptable but will require adjustments going forward.
- A limited S-G program cost pro forma indicates a positive result for income versus expenses for teaching the yearly S-G course group, assuming a yearly cohort of twenty students at GSU.
- Program success metrics of communication effectiveness, increased enrollment tracking, student exam (e.g., fundamentals of surveying [FS] and professional surveyor [PS] exams) success, and student employment/career success were identified to measure the success of the S-G program at GSU.

RECOMMENDATIONS

Surveying–Geomatics Survey Follow-up

As a follow-up to the S-G survey, the research team anticipates that the second S-G stakeholder meeting can be held at the Surveying and Mapping Society of Georgia (SAMSOG) Summer Meeting to be held in July 2021. It was further proposed that the following be presented at this Summer Meeting:

- The S-G survey results from this research in a summarized form.
- A presentation to support some of the questions in the original S-G survey.
- The current scope of Geospatial Science and Imaging Science in the S-G environment.

S-G Program Recommendations

It was recommended that GDOT enlist a statewide campaign, including personnel from GDOT and other State government departments in Georgia who perform S-G work or who procure S-G services, to inform them about available S-G education and to introduce the idea of including S-G education requirements and LSIT/PLS licensure requirements in their appropriate position descriptions. It was further recommended that an endorsement by GDOT Commissioner McMurry be sought for S-G education requirements and LSIT/PLS licensure requirements. Also, it was proposed that GSU's S-G education program be made a part of the available GDOT education programs or a partner with GDOT for S-G programs in education not just through research.

It was recommended that S-G education/licensure be a requirement for S-G consultants utilized by GDOT, if not already in place. In addition, it was recommended that GSU investigate an educational relationship between the GSU S-G program and the appropriate Technical College System of Georgia (TCSG) colleges. Finally, it was recommended that GSU's S-G program should investigate assisting GDOT with the National Geodetic Survey's (NGS) transition from the current state plane coordinate system to the new proposed International Terrestrial Reference Frames (ITRF).

Future Research Recommendations

- A data mining report should be developed from the detailed S-G survey data. This report should take the form of a research paper for the *Surveying and Geospatial Information Science* (SaGIS) journal or the American Society of Civil Engineering (ASCE) *Journal of Surveying Engineering.*
- The application of a public–private partnership (PPP) relationship for maintaining the highest level of S-G education and S-G service for private industry and the public should be investigated.

- The best way to educate S-G personnel on the changes proposed with the NGS ITRF initiative should be investigated.

IMPLEMENTATION

The implementation of key elements from this research would include the following:

- Inclusion of S-G education and licensure in the position descriptions for GDOT's S-G positions.
- Inclusion of the GSU S-G program as a support group for the GDOT organization.
- Promotion of the GSU S-G program as a path for S-G education and future PLS licensure.

CHAPTER 1. INTRODUCTION

Recovering from the effects of a recently weakened economy (and now, a pandemic), many states, including Georgia, are experiencing a new need for employees with surveying–geomatics (S-G) education and field experience. In addition, Georgia and many other states have an education system that does not serve the needs of place-bound students, such as Georgia Department of Transportation (GDOT) personnel and others in surveying–geomatics. Many Georgia State agencies and local governments that GDOT works with on a continual basis are required to provide services that, in turn, require personnel with a twenty-first century education (i.e., knowledge and skill) in S-G. Driven by many factors, including lack of traditional student interest, lack of student preparedness, retirement-replacement issues, ever expanding technology and education materials, post-recession demand, and many other intangible factors, the entire Georgia S-G community has recognized the need for an adaptive approach to surveying–geomatics education.

Current funding to Georgia's colleges and universities, which provide Georgia's S-G education, has become insufficient and it has become apparent that a collaborative/supportive effort among all S-G stakeholders is required to establish sustainable sources of complementary funding and to establish an S-G education program for future place-bound S-G students. Thus, it is proposed that this effort should be championed by GDOT to ensure that all the needs of the various impacted GDOT departments are met while improving the quality of surveying–geomatics across the state. Many S-G stakeholders, including GDOT, could be better served by an education program that provides access to place-bound students. In addition to education, many individuals could have a path to land surveying licensure.

All the above reasons posit a need for the research contained in this report, in which the influencing factors for the current state of S-G education in Georgia are examined and a new approach to S-G education is developed. Thus, it is hoped that with a strong implementation of the S-G program, the place-bound student can obtain a quality S-G education without the expense of excessive travel, and the State of Georgia will prepare a larger cohort of students for the twenty-first century in surveying–geomatics. Finally, in order to achieve the goals of this research, the following tasks were completed as given in the following sections of the report:

- Task 1: Development of S-G knowledge/skill matrix
- Task 2: Development of S-G employment positions matrix
- Task 3: Development of S-G education/subject coverage matrix
- Task 4: Development, issuance and collection of S-G surveys
- Task 5: Quantitative/Qualitative data analysis and present findings
- Task 6: Development of S-G program definition and preparation of final report and recommendations.

CHAPTER 2. TASK 1: DEVELOPMENT OF SURVEYING–GEOMATICS KNOWLEDGE/SKILLS MATRIX

LITERATURE REVIEW

Overview

Across the United States, the qualifications and training required of a surveyor can result in different career paths for university/college versus non-traditional students. Graduates usually have a degree in geomatics or geospatial science or a related subject, such as geophysics, geology, geography, geotechnology, or the earth sciences. Civil engineering, planning, surveying, or construction degrees can also be accepted by employers, especially if they include relevant surveying–geomatics subjects (Target Jobs 2021). Employers may require the degree to be from an accredited program. The degree can be accredited by a relevant professional body such as ABET (formerly the Accreditation Board for Engineering and Technology). Finally, depending on the institution and/or training pathway, obtaining a professional qualification (i.e., professional surveying license) can take between two and five years (or more) to complete the work-based study and final assessment (Target Jobs 2021).

Review of Scope of S-G Knowledge and Skills

According to the National Park Service (NPS), U.S. Department of the Interior (National Park Service 2021), the essential competencies required of a land surveyor can be grouped into three levels: entry level, developmental level, and full performance level. These levels have been found to have significant similarities to surveying–geomatics jobs at the Georgia Department of Transportation and other states in the United States. These competency levels are as described below.

Entry Level

This competency level identifies the knowledge, skills, and abilities required to independently conduct field surveys as chief of a survey crew and gather survey data for the preparation of survey plats. Work is assigned with detailed and specific instructions and guidance. Work elements can include:

<u>Land Title/Land Records</u>

- Understanding of Federal and State land survey and boundary law.
- Performs and assists in research of public records to determine routine title and boundaries. Ability to read and interpret routine survey records and deeds.
- Understanding of real estate law related to surveying.

<u>Land Surveys</u>

- Understanding of survey principles and practices.
- Operation of total station, theodolite, and electronic distance measuring equipment.
- Performs intermediate surveying computations to include traversing, inversing, translation, and rotation of data; simple curves; closures of figures; and areas.
- Understanding of surveying software and computer aided design (CAD) equipment in preparation of survey plats.
- Inspects and reviews contract surveys for conformance with contract specifications.
- Ability to prepare and write legal descriptions from deeds of record and from data acquired from field surveys.

The knowledge, skills, and abilities required for an entry-level position of a land surveyor include:

- Knowledge of the principles and practices of cartography.
- Knowledge of Land Acquisition Procedures.
- Knowledge of algebra, geometry, and trigonometry.

Developmental Level

This category of surveyor's competency level represents the level where a surveyor can serve as party chief in charge of difficult land surveys or as a contracting officer's technical representative. The surveyor can be a representative on routine survey contracts. The work responsibilities at this level are generally assigned with little instruction or guidance except for unprecedented survey problems.

<u>Land Title/Land Records</u>

- Comprehensive knowledge of Federal and State land survey law and boundary law.
- Performs independent research of public records to determine title and boundaries in difficult cases. Ability to read and interpret complex or ambiguous survey records.
- Sound knowledge of real estate law related to surveying.

<u>Land Surveys</u>

- Knowledge of survey principles and practices.
- Operation of GPS equipment.
- Knowledge of survey software and CAD equipment necessary for performing survey computations and preparation of survey plats.

- Independently inspects, reviews, and approves payment on contract surveys and has comprehensive knowledge of contracting officer's technical representative responsibilities and architectural and engineering (A/E) contract requirements.

The knowledge, skills, and abilities required for a developmental-level position of a land surveyor include:

- All knowledge, skills, and abilities at the entry level plus:
    - Ability to use sound judgment in applying surveying principles and techniques in the resolution of problems caused by inadequate and inconclusive data.
    - Understanding of Federal land acquisition procedures.

Full Performance Level

At a full performance level, a surveyor is required to have the capabilities to conduct land surveys involving complications and complexities, such as incorrect prior surveys, unrecoverable monumentation, and conflicting land records and survey data. The surveyor can also serve as a contracting officer’s technical representative on survey contracts involving areas with complex survey problems. The work at this level is also assigned with little or no guidance, even on surveys with complex problems.

<u>Land Title/Land Records</u>

- Ability to incorporate recent court decisions and opinions of survey law to current survey practice.
- Ability to reconcile conflicting public records to produce defensible surveys necessary for litigation.

Land Surveys

- Comprehensive knowledge of survey principles and practices.
- Ability to conduct land surveys involving multiple complications.
- Comprehensive knowledge of software, desk, and CAD equipment necessary for performing advanced survey computations and preparation of intricate survey plats.
- Independently inspects, reviews, and approves payment on contract surveys and resolves all contractor surveying problems that arise, as well as disputes over payments.
- Also develops all architectural and engineering survey specifications.

The knowledge, skills, and abilities required at the full performance–level position of a land surveyor include but are not limited to:

- All knowledge, skills, and abilities at the entry and developmental levels plus:
    - Ability to lead and instruct subordinates in the performance of survey tasks and completion of assigned survey projects.

These three competency levels show the progression in the field of surveying–geomatics.

Sources of S-G Knowledge and Skill Descriptions

The following sources give different breakdowns for knowledge and skill requirements that the professional surveyor (PS) ultimately needs to have.

ABET

ABET has summarized the criteria for Surveying and Similarly Named Engineering Programs as given below:

- Lead Society: National Society for Professional Surveyors (NSPS); Cooperating Society: American Society of Civil Engineers (ASCE).
- ABET program criteria apply to engineering programs that include surveying, geomatics, or similar modifiers in their titles.
    - Curriculum

      The curriculum must include:

        - Mathematics, including statistics, to support analyses of complex surveying/geomatics problems.
        - Historical and legal elements of land ownership, particularly where surveying/geomatics are an integral part.
        - Data science and analysis for conformance of precision and accuracy.
        - Data structure, format, storage, management, publication, visualization, and the related legal responsibilities to the public.
        - Modern measurement and design technologies necessary to model, locate, or construct features above, below, or on the Earth's surface.
        - Added depth in a minimum of four subject areas, consistent with the program's educational objectives, chosen from the following:
            - Boundary or land surveying.
            - Engineering surveys.
            - Photogrammetry and remote sensing.
            - Geodesy and geodetic surveying.
            - Mapping including map projections and coordinate systems.
            - Geospatial data science and land information systems.

- Civil engineering topics that assist the student in meeting the requirements for licensure in the state or region.

National Council of Examiners for Engineering and Surveying

The National Council of Examiners for Engineering and Surveying (NCEES) provides two examinations in which the knowledge and skills of surveying license candidates are tested: the Fundamentals of Surveying (FS) exam and the Principles and Practice in Surveying (PS) exam. The topics covered by these exams are given below:

- Fundamentals of Surveying Exam:
    - Surveying processes and methods.
    - Mapping processes and methods.
    - Boundary law and real property principles.
    - Surveying principles.
    - Survey computations and computer applications.
    - Business concepts.
    - Applied mathematics and statistics.
- Principles and Practice in Surveying Exam.
    - Legal principles.
    - Professional survey practices.
    - Standards and specifications.
    - Business practices.
    - Areas of practice.

The Georgia Board of Professional Engineers and Land Surveyors

The Georgia Board of Professional Engineers and Land Surveyors has applications for the Land Surveyor in Training (LSIT) and Land Surveyor, which include the NCEES FS exam and the NCEES PS exam, respectively. Along with these exams, applications are required that include the following experience components, which require the knowledge and skills required by applicants at these two levels. Also shown are the course descriptions developed by the Board for the required courses, which are included in the application.

- Land Surveyor in Training application:
    - Boundary surveying (including research and calculations).
    - Topographic or as-built surveying.
    - Geodetic or GPS surveying.
    - Construction layout/staking.
    - Other.
    - LSIT Required Course Criteria:
        - <u>S1: Foundation in surveying</u>. The course would cover the basics of surveying coordinate geometry; surveying calculations, traversing, and leveling; topography and contours; proper field procedures; and basic cartography. Prerequisites should include trigonometry and a course in drafting, engineering graphics, CAD, cartography, or similar background. Course should include a lab in surveying, measurements, etc. This course might be offered under names such as “Elementary Surveying,” “Surveying 1,” “Geomatics Measurements,” etc.

- S2: Advanced surveying course. The course would cover state plane coordinates, mapping projections, advanced field techniques, route and alignment surveys, volumetric calculations, construction staking techniques, and data collection. Appropriate lab application should be included in the course. This course might be offered under names such as "Advanced Surveying," "Route Surveying," "Surveying 2," etc.
- S3: Legal Aspects course. The course would include history of land division systems, basic property rights, legal descriptions, written conveyances, unwritten conveyances, retracing the footsteps of older surveys, junior–senior rights, prescription and adverse possession, hierarchy of controlling monuments and title elements, disputes, and litigation. This course might be offered under names such as "Legal Aspects of Surveying," "Boundary Law," "Property Law," etc.
- S4: Professional Practice course. The course would prepare the applicant for professional practice as a Professional Land Surveyor and would include subdivision design, site layout, zoning and land use regulations, professional ethics, and business practice.
- S5+: Additional courses in surveying and related applicable fields include higher level material, such as geographic information system (GIS), geodesy, geodetic surveying, photogrammetry, advanced boundary law, remote sensing, dendrology, spatial analysis, and surveying adjustments. Partial credit may be given for some courses that contain partially applicable material.

For Hydrology and Design Authorization

  - <u>HP1: Hydrology Prerequisite 1</u>. This course would follow a physics sequence and cover the general engineering principles of mechanics and statics.
  - <u>HP2: Hydrology Prerequisite 2</u>: This course would follow the mechanics/statics course and concentrate in fluid mechanics, pressurized flow, and hydraulics.
  - <u>AH: Applied Hydrology</u>: This course covers watershed analysis and the design of culverts, multi-structure systems, retention ponds, and open channel flow.

- Land Surveyor application:
  - Boundary surveying (including research and calculations).
  - Topographic or as-built surveying.
  - Geodetic or GPS surveying.
  - Construction layout/staking.
  - Other.

National Society of Professional Surveyors

The National Society of Professional Surveyors (NSPS) has the following policy statement, which calls for a bachelor's degree as the minimum education for a surveying license:

> *By vote of the NSPS Board of Directors on October 24, 2014, the NSPS Education Policy states: "The official position of the National Society of Professional Surveyors shall be that a Bachelor's Degree in Surveying, Surveying Engineering,*

or Surveying Engineering Technology be the minimum educational requirement for licensure as a Land Surveyor in all jurisdictions." (NSPS 2014)

Endorsed by the NSPS, a series of surveying body of knowledge (SBoK) documents for S-G were written in 2010–2011 and following by prominent authors and educators with established expertise in the subjects of their papers. These papers broke down the knowledge and skill requirements for different levels of S-G application and they were focused around fulfilling a broad spectrum of subject areas, as shown in figure 1.

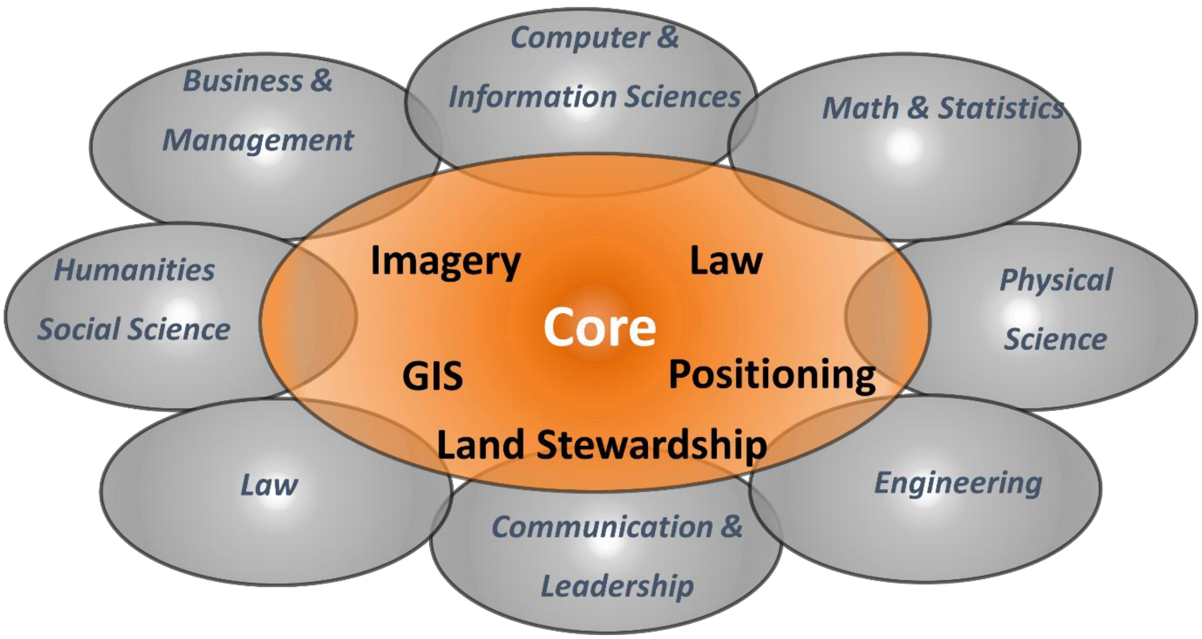


Figure 1. Diagram. Surveying body of knowledge. (Greenfield 2011b)

The five core areas given by these SBoK papers are discussed below to indicate how they are related to and influence the surveying body of knowledge (Purcell 2014).

NSPS Surveying Body of Knowledge – Legal Aspects

The legal core area stresses the importance of surveying and the profession's authority to determine boundaries as defined by administrative, legislative, and local legal systems. The legal body of knowledge emphasizes that:

> *"…knowledge of the law is not only significant but is a crucial element of the overall SBoK. Of all of the activities that fall under the umbrella of 'surveying'. The surveyor's interaction with the law and how the law relates to property rights—specifically property rights associated with the location of boundaries—is the only justification for requiring surveyors to be licensed under the vast majority of jurisdictions, if not all of them." (Lathrop and Lucas 2011)*

The legal SBoK definition emphasizes the breadth and depth of the knowledge required even at the core level, which is necessary for all surveyors. As such, it is obvious that the necessary legal education for a surveyor cannot be contained in a single three-hour college course and, thus, the newly summarized legal body of knowledge adds to the educational compression of college courses currently being taught.

NSPS Surveying Body of Knowledge – Land Stewardship

While the concept of surveyors practicing a stewardship role in conjunction with real property is not foreign to most surveyors, the quantification of the surveyor's stewardship functions may be new to some surveyors. In this SBoK, the protection of the natural and human environments requires the practice of stewardship in "professional functions which include land use, site development, and resource management in the natural and social environment…" (Lathrop and Lucas 2011) The general knowledge areas required to support these stewardship functions include: communication skills; site design and resource management; site restraints and assets; and project organization, management, and administration (Lathrop and Lucas 2011). As with the legal SBoK, the land stewardship body of knowledge adds to the educational compression of college courses currently being taught.

NSPS Surveying Body of Knowledge – Positioning

The content of NSPS's SBoK for positioning may be the specialty SBoK with which land surveyors associate the most directly. The knowledge areas (first-level breakdown) for positioning include: measurements; physical laws; solid geometry and other mathematical tools; computer tools; error estimation, error propagation, least squares adjustment and other tools; standards and specifications; information management; communication principles; and economic, legal, and business concepts (Paiva 2011). Most of these knowledge areas are covered at least to some extent in the Foundation Geomatics Surveying (FGS) course, which is one of the primary activity subjects of this research. The impact of positioning tools such as GPS, the uses of laser-assisted equipment for scanning and other purposes, plus the applications of information technology (IT) in voice and data communications have expanded the amount of knowledge required by S-G students and professionals. Thus, this expansion applies to the scope of the FGS course and makes the understanding of the mathematics and physics even more important. Student learning becomes more critical with the expansion of subject coverage and the increasing daily demands of the students—especially online students.

NSPS Surveying Body of Knowledge – Geospatial Science

The geographic information system (GIS) or geospatial science SBoK is probably the most controversial since it is a relatively new addition to the S-G professional's toolbox and creates an overlap of responsibilities between the S-G professional and the GIS professional. In this NSPS SBoK, the knowledge areas have been extracted as a subset of the GIS SBoK that was developed by the Association of American Geographers (AAG) and the University Consortium for Geographic Information Science (UCGIS). The knowledge areas for S-G professionals in GIS include: conceptual foundations, data mining, design aspects, data manipulation, analytical methods, cartography and visualization, legal and ethical aspects of GIS, and management and organizational aspects (Greenfield 2011a). Since "the minimal level of GIS knowledge a surveyor must master should enable him/her to routinely use basic GIS technology," this is a subject that is introduced in the FSG course and adds to the expansion of education requirements of the FSG student (Greenfield 2011a).

NSPS Surveying Body of Knowledge – Imaging Science

For the S-G professional, "imaging refers to the capturing a scene by means of light intensities. Image products are often 2D geometric projections of a 3D scene...The formal name that goes with the subject of imaging, sensor calibration and 3D scene reconstruction is Photogrammetry." (Bethel 2011) The imaging knowledge areas include cameras and photography; radiometry, detection, and sensing; frame geometry; image measurements; stereoscopy and parallax; mathematical modeling and analytical photogrammetry; computer vision; estimation, adjustment, statistics, and error propagation; stereo resolution; rectification and resampling; mapping and cartography; topography and digital elevation modeling; digital photogrammetry; project planning; close-range photogrammetry; satellite photogrammetry; remote sensing; and active sensing with LiDAR (Bethel 2011). While photogrammetry has been a subject of course coverage in surveying for many years, the application of IT and digital photography has greatly expanded the scope of the imaging SBoK and, thus, certificate programs and degree programs in S-G have had difficulty in keeping up with the knowledge and skill expansion in this area.

DEVELOPMENT OF SURVEYING-GEOMATICS KNOWLEDGE/SKILLS MATRIX

Based on the breadth and depth of the SBoK articles and the fact that they supported the five key areas of S-G (i.e., positioning, geospatial science, imaging science, land stewardship, and legal aspects), the research team decided to follow the analyses given by these articles to develop the S-G knowledge/skills matrix, which in turn would be used to develop a series of questions identified for the project survey. Each one of the SBoK articles included a table that shows the areas of knowledge and skills associated with that area, along with the common three levels of competency (i.e., core, specialist, scholar [research and development]) and their associated level of knowledge (i.e., recognition, understanding, and ability). Table 1 provides an example of this analysis for the positioning area of competency. All five of the SBoK tables that were used to develop the surveying–geomatics knowledge/skills matrix are provided in appendix A of this report.

Continuing with this example for positioning, the knowledge areas and tasks were extracted from the table, and columns for priority, frequency, and personnel responsibility level were added to enable the validation of the matrix. Thus, for priority, the scale was 0 to 5, where 0 = no priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, and 5 = highest priority or necessity. For performance frequency, the scale was 0 to 5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly, and 5 = daily. The assignment of personnel responsibility was left to the respondent since this variable would depend on the employer’s job position description and hierarchy. The results of this effort culminated in five working tables, i.e., one table for each of the five key areas of S-G. Table 2 shows the table for positioning area. All five of the tables represent the deliverable for Task 1 of this project and are provided in appendix B of this report.

Table 1. Surveying‑geomatics body of knowledge level of competencies: Positioning.

Competency in Knowledge Area: Measurement	Core	Specialist	Scholar/ R&D
1. Situational analysis	A	A	U
2. Technology and measurement regimen selection	A	A	U
3. Systematic error analysis	A	A	A
4. Application of mathematical models for data and information representation	A	A	A
5. Designing or applying survey control	U	A	A
6. Field survey	A	A	R
Competency in Knowledge Area: Data Analysis and Management			
1. Examine data for completeness	A	A	A
2. Post-processing for systematic and random error reduction and evaluation	A	A	A
3. Analyze data for precision; draw conclusions about accuracy	A	A	A
4. Determine if additional measurements are required	A	A	A
5. Integrate data from various sensors into a homogenous database	U	U	A
Competency in Knowledge Area: Adjustments			
1. Apply different adjustment procedures for data processing	A	A	A
2. Apply statistical and adjustment tools to improve quality of information being reported	U	A	A
3. Calculate integrity of networks and other geometries	U	A	A
4. Apply principles of geodesy	R	A	A
Competency in Knowledge Area: Coordinate Geometry			
1. Apply 2D and 3D transformations	U	A	A
2. Determine projected coordinates	U	A	A
3. Determine geodetic coordinates	R	A	A
4. Determine positions of surveyed points	A	A	A
5. Determine position or configuration of designed points, lines, surfaces, and volumes	A	A	A
6. Determine areas and volumes	A	A	A
Competency in Knowledge Area: Information Extraction			
1. Report positions, lines, surfaces, and volumes	A	A	A
2. Report conclusions, deductions, and inductions	A	A	A
3. Create maps and reports that are project and “consumer-specific”	A	A	A
4. Use CAD/GIS to generate user products	A	A	A

R = recognition, U = understanding, and A = ability

Table 2. Surveying‑geomatics: Knowledge and skill matrix: Positioning.

Surveying–Geomatics Body of Knowledge Scope: Positioning				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A. Measurement	1. Situational analysis			
	2. Technology and measurement regimen selection			
	3. Systematic error analysis			
	4. Application of mathematical models for data and information representation			
	5. Designing of applying survey control			
	6. Field survey			
B. Data Analysis and Management	1. Examine data for completeness			
	2. Post processing for systematic and random error reduction and evaluation			
	3. Analyze data for precision; draw conclusions about accuracy			
	4. Determine if additional measurements are required			
	5. Integrate data from various sensors into a homogenous database			
C. Adjustments	1. Apply different procedures for data processing			
	2. Apply statistical and adjustment tools to improve quality of information			
	3. Calculate the integrity of networks and other geometries			
	4. Apply principles of geodesy			

Surveying–Geomatics Body of Knowledge Scope: Positioning				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
D. Coordinate Geometry	1. Apply 2D and 3D transformations			
	2. Determine projected coordinates			
	3. Determine geodetic coordinates			
	4. Determine position of surveyed points			
	5. Determine position or configuration of designed points, lines, surfaces, and volumes			
	6. Determine areas and volumes			
E. Information Extraction	1. Report positions, lines, surfaces, and volumes			
	2. Report conclusions, deductions, and inductions			
	3. Create maps and reports that are projected and "consumer specific"			
	4. Use CAD to generate user products			
	5. Use GIS to generate user products			

Priority (importance); (Scale 0–5, where 0 = no priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, and 5 = highest priority or necessity)
Performance Frequency; (Scale 0–5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly, and 5 = daily)
Personnel Responsibility Level; TBD

VALIDATION OF S-G KNOWLEDGE AND SKILLS MATRIX

To validate the S-G knowledge and skills matrix for applicability and reasonableness, the five-part matrix was given to GDOT representatives, Location Bureau Chief Mr. Benny Walden and Statewide Consultant Compliance Supervisor Mr. Michael Lewis, for their evaluation of priority, frequency, and personnel responsibility level. The results of their evaluation indicated that the matrix evaluation was comprehensive for surveying–geomatics tasks within the GDOT organization. The results of their evaluation (highest-level ranking) for priority and frequency are provided in the following statements. The information for the personnel responsibility levels and complete ranking information are provided in the complete set of tables provided in appendix C of this report. The positioning table is provided in table 3 below.

- Under the area of positioning, GDOT ranked the sub-knowledge area of data analysis and management and measurement at a tie score of 5.0/5.0 for priority and ranked coordinate geometry with a score of 4.0/5.0 for frequency. (Refer to table 3 for detailed information.)
- Under the area of geospatial science, GDOT ranked the sub-knowledge area of analytical methods at a score of 4.2/5.0 for priority and ranked geospatial data with a score of 4.0/5.0 for frequency.
- Under the area of imaging science, GDOT ranked the sub-knowledge area of stereoscopy and parallax at a score of 5.0/5.0 for priority and ranked topography and digital elevation modeling with a score of 4.0/5.0 for frequency.

- Under the area of land stewardship, GDOT ranked the sub-knowledge area of project administration, management, and organization at a score of 2.63/5.0 for priority and with a score of 2.2/5.0 for frequency.
- Under the area of legal aspects, GDOT ranked the sub-knowledge area of legal systems and legal resources at a tie score of 3.0/5.0 for priority and ranked legal resources with a score of 2.8/5.0 for frequency.

With the S-G knowledge and skills matrix validated, the question set covering knowledge and skill requirements was produced utilizing the matrix and the validation results. The development of the questions on S-G knowledge and skills is covered in chapter 5 of this report.

STAKEHOLDER CONTACT DATABASE DEVELOPMENT

Overview

Delivery of the project survey (developed in chapter 5 of this report) to the right respondents (stakeholders) required an arduous process of internet search and utilization of existing databases. This process resulted in a combination of an email contact database and a direct mail (i.e., U.S. postal service) list. The development of the stakeholder email contact database was a time-intensive operation that involved searching through public records found through keyword searches on Google's web search engine and through the websites for each identified agency. The process was essentially the same for the Federal, State, and local agencies. Another source for the stakeholder email contact list was the Surveying and Mapping Society of Georgia (SAMSOG) contact database. SAMSOG provided this database solely for this project at no cost. An additional database source was the Georgia Board of Registration for Professional Engineers and Land Surveyors (GBORPELS) website, which contains contact information for registered land surveyors.

Table 3. Surveying-geomatics: Knowledge and skill matrix: Validation.

Surveying-Geomatics Body of Knowledge Scope: Positioning				
Knowledge Area	**Associated Task**	**GDOT Priority**	**GDOT Frequency**	**GDOT Personnel Responsibility Level**
A.) Measurement	1.) Situational analysis	5	4	ASPC and above
	2.) Technology and measurement regimen selection	5	4	ASPC and above
	3.) Systematic error analysis	5	3	ASPC and above
	4.) Application of mathematical models for data and information representation	5	3	ASPC and above
	5.) Designing of applying survey control	5	4	ASPC and above
	6.) Field Survey	5	5	ST AND ABOVE
B.) Data Analysis and Management	1.) Examine data for completeness	5	5	ASPC and above
	2.) Post processing for systematic and random error reduction and evaluation	5	3	ASPC and above
	3.) Analyze data for precision; draw conclusions about accuracy	5	3	ASPC and above
	4.) Determine if additional measurements are required	5	4	ASPC and above
	5.) Integrate data from various sensors into a homogenous database	5	3	ASPC and above
C.) Adjustments	1.) Apply different procedures for data processing	4	1	ASPC and above
	2.) Apply statistical and adjustment tools to improve quality of information	5	3	ASPC and above
	3.) Calculate the integrity of networks and other geometries	5	3	ASPC and above
	4.) Apply principles of geodesy	5	3	ASPC and above
D.) Coordinate Geometry	1.) Apply two-dimensional and 3D transformations	4	3	ASPC and above
	2.) Determine projected coordinates	5	4	ASPC and above
	3.) Determine geodetic coordinates	5	4	ASPC and above
	4.) Determine position of surveyed points	5	5	ASPC and above
	5.) Determine position or configuration of designed points, lines, surfaces, and volumes	5	5	ASPC and above
	6.) Determine areas and volumes	4	3	ASPC and above
E.) Information Extraction	1.) Report positions, lines, surfaces, and volumes	5	3	ASPC and above
	2.) Report conclusions, deductions, and inductions	4	3	ASPC and above
	3.) Create maps and reports that are projected and "consumer specific"	5	4	SPC and above
	4.) Use CAD to generate user products	5	5	ASPC and above
	5.) Use GIS to generate user products	5	4	

Knowledge Area	GDOT Priority - TP	GDOT Priority - AP	GDOT Frequency -TP	GDOT Frequency - AP
A.) Measurement	30	5.00	23	3.83
B.) Data Analysis and Management	25	5.00	18	3.60
C.) Adjustments	19	4.75	10	2.50
D.) Coordinate Geometry	28	4.67	24	4.00
E.) Information Extraction	24	4.80	19	3.80
TOTAL	126	4.84	94.00	3.55

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
GDOT Personnel Responsibility Level; TBD

Surveyors in Georgia

The GBORPELS contact list was used to help complete the overall database by providing update information missing from the SAMSOG database. This GBORPELS contact list included the recently registered surveyors.

The process used for finding the contact information for the Federal, State, and local agencies was relatively simple, but common issues were found. For some of the agencies, their websites were not user-friendly, had little to no information, or did not exist at all (only for local agencies). Another common issue with some agencies was that the only way to contact them was through a contact form on their website (i.e., no contact information was provided). Most of the local agencies (i.e., towns and cities) that did not have contact information lists were able to be grouped into their respective counties because most counties did have their contact information available on their website.

Federal Agencies

The contact list for Federal agencies started with an identification of the agencies that are most likely involved in surveying and geomatics applications. Then, a keyword search was performed using the target words for S-G. This process typically narrowed the search field down to parts of the agency involved in an S-G application. Next, an examination of parts of the agency was conducted to find a contact that uses S-G applications. It was noticed that the process was easier for State agencies than for Federal agencies because most of the State agency websites had more information than the Federal agency websites. In all, 32 Federal agencies with usable contact information were identified in this process.

State Agencies

The contact list for the Georgia State agencies started with an identification of agencies that are most likely involved in surveying and geomatics applications. The resulting list was targeted first, and then other agencies found on the State of Georgia website (Georgia State Government, 2021) were evaluated. The first step was performing a keyword search for surveying and geomatics topics to find relevant data in each of the agencies. This process helped the researchers locate the general location on the website where they could find a contact that was involved with the S-G field. After finding the general area, the search was narrowed down to the job positions and then finally to the individual contact. It was common for the agency websites not to mention S-G applications. Therefore, to find a contact, each job position in the agency was examined until the researchers found a related field and contact. Ultimately, 49 State agencies with usable contact information were identified in this process.

Local Agencies

The contact list for local agencies was created from a list of Georgia counties, cities, and towns found on the State of Georgia website (Georgia State Government 2021). The contact list was broken down by county, city, and town citing an overall contact for the county and then contacts for each city and town. This process involved searching through county websites to find the city/county engineer, or city/county public works director, or city/county manager or commissioner. If one of these positions could not be found, the city clerk or a councilman was used as the contact. While finding the contacts, the populations were also recorded to be able to rank them from largest to smallest. The most difficult issue to overcome during this process was that of finding contact information for counties/cities with very small populations. For cities and towns with no contact information listed, the county contact information was used. A total of 526 local agencies (i.e., cities/towns) with usable contact information were identified in this process.

SAMSOG Contacts

The SAMSOG membership/supporters list was provided by SAMSOG and was used to find emails and addresses for registered surveyors. The given spreadsheet was extremely data intensive. Thus, it was edited, and only relevant data were kept. This process involved going through each column of the spreadsheet and determining if the data were relevant to the project or not. Most of the data on the spreadsheet were not needed and, thus, the size of the sheet was greatly reduced. Most of the members on the list provided an email address. For the members who did not provide an email, their mailing address was used as their point of contact. In all, 1,903 SAMSOG members with usable contact information were identified in this process.

GBORPELS Contacts

A noncurrent information list for the GBORPELS contacts was provided by SAMSOG and was used to find addresses/emails for licensed surveyors. The provided list had to be updated to include the most recently registered surveyors. The updating process was done using the GBORPELS website (Georgia Secretary of State 2018a), which contains a database with information on Georgia's registered surveyors. However, emails were not included in the database. Therefore, the mailing addresses were extracted to be used as the point of contact. A duplication check between the SAMSOG-provided list and the GBORPELS website (Georgia Secretary of State 2018a) contacts list was performed. Several duplicates were found, and the most current contact information was utilized, thus eliminating duplication in the final listings. This process helped reduce the size of the required mailing list (i.e., mail-outs) because most of the entries on the SAMSOG-provided GBORPELS list were on the SAMSOG contact list, which had an email address. A total of 637 registered surveyors with usable contact information were identified in this process.

Final Email List and Mail List

After all the contact information was compiled, the final lists were created. The first list contained all the email addresses that were found from the State, Federal, and local agencies and from the edited GBORPELS information list. This final email list contained 2,350 email addresses, along with the associated contact names. The second final list contained all the mailing addresses for contacts where emails could not be found. This final list contained 637 addresses, along with the contact names. Specific detailed information on the final contacts has not been provided in the report to maintain survey respondent anonymity.

CHAPTER 3.
TASK 2: DEVELOPMENT OF SURVEYING–GEOMATICS EMPLOYMENT POSITIONS MATRIX

LITERATURE REVIEW

Overview

According to the United States Bureau of Labor Statistics (2021), employment of surveyors is projected to grow 2 percent from 2019 to 2029, slower than the average for all occupations. Despite this, surveyors will continue to be needed to certify boundary lines, work on resource extraction projects, and review sites for construction. However, the use of drones and other technologies is expected to increase worker productivity and may, therefore, limit employment growth. This may further lower the employment rate for surveyors and may be a potential problem that may hinder the availability of surveying–geomatics jobs.

In terms of job prospects, those with knowledge of a variety of surveying specializations and a bachelor's degree from an ABET-accredited school will have the best job opportunities. Demand for traditional surveying services is closely tied to construction activity; therefore, job opportunities will vary by geographic region and often depend on local economic conditions. However, because surveyors can work on many different types of projects, they may have steadier work than others in the industry when there is a decrease in construction works.

According to the U.S. Bureau of Labor Statistics (2020), the industries with the highest published employment for surveyors are summarized in table 4.

Table 4. Employers of surveyors across all institution in the United States. (U.S. Bureau of Labor Statistics 2020)

Industry	Figures	Percentage
Architectural, engineering, and related services	33,070	69%
Local government (excluding schools and hospitals)	2,550	14%
Construction (highway, street, and bridge construction)	1610	10%
Self-employed workers (management, scientific, technical consulting)	960	5%
Mining, quarrying, and oil and gas extraction	620	2%

In Georgia, the researchers were able to identify the distribution of surveying jobs in some counties based on the location quotients. The location quotients were expressed as the ratio of an area's distribution of employment by industry to a referenced area's distribution. The value of local quotient should be equal to 1 for average employment concentration. For location quotient values less than 1, the employment concentrations are typically below average, and the employment concentration is above average for values greater than 1. The location quotient of certain counties in Georgia has been computed and summarized in table 5.

For this research project, the State of California was selected as a basis of comparison with the employment of surveying–geomatics jobs in Georgia. The selection was based on the fact that California is one of the largest states in the United States with a robust transportation system. The percentages of surveying–geomatics employment availability in the United States, California, and Georgia are summarized in table 6.

Table 5. Employment of surveyors across Georgia.
(U.S. Bureau of Labor Statistics 2020)

Rank	Region	2019 Employment Concentration Level	Location Quotient
1	Warner Robins, GA, Metro Area	Above average	3.28
2	Athens–Clarke County, GA, Metro Area	Above average	1.67
3	East Georgia Balance of State	Above average	1.47
4	Savannah, GA, Metro Area	Average	1.28
5	North Georgia Balance of State	Below average	0.83
6	Chattanooga, TN–GA, Metro Area	Below average	0.70
7	Georgia	Below average	0.63
8	Atlanta–Sandy Springs–Roswell, GA, Metro Area	Below average	0.56
9	Augusta–Richmond County, GA–SC, Metro Area	Below average	0.50
10	Macon–Bibb County, GA, Metro Area	No data available	No data available
11	South Georgia Balance of State	No data available	No data available
12	Rome, GA, Metro Area	No data available	No data available
13	Valdosta, GA, Metro Area	No data available	No data available
14	Brunswick, GA, Metro Area	No data available	No data available
15	Albany, GA, Metro Area	No data available	No data available
16	Columbus, GA–AL, Metro Area	No data available	No data available
17	Middle Georgia Balance of State	No data available	No data available
18	Gainesville, GA, Metro Area	No data available	No data available
19	Hinesville, GA, Metro Area	No data available	No data available
20	Dalton, GA, Metro Area	No data available	No data available

Table 6. Surveying‑geomatics employment availability.
(U.S. Bureau of Labor Statistics 2021)

Geographical area	Employment	Percentage
United States	53,030	N/A
California	4,110	7.7 %
Georgia	1,370	2.5%

From findings in this project, the job projection is relatively lower for Georgia when compared to California. This comparison will help the State of Georgia take proactive measures to increase the availability of surveying–geomatics positions in Georgia in the future.

The projected annual openings for surveying–geomatics jobs in the United States, California, and Georgia are summarized in table 7.

Table 7. Surveyor employment projection in the United States. (U.S. Bureau of Labor Statistics 2020)

Region	Employment		Percentage Change (%)	Projected Annual Job Openings
	2018	2028		
United States	49,200	52,200	6	4,000
California	2,802	4,260	34	163
Georgia	910	1,100	20	90

A comprehensive positions matrix will show the current state of surveying–geomatics jobs in Georgia, the California Department of Transportation (Caltrans), and California, though the job availability is subject to several factors, including the economic situation and the geographical location.

Investigation of Surveying–Geomatics Positions in Private Industry

The term *geomatics* is a relatively new one, which was adopted by the industry less than 50 years ago. At its core, the industry has evolved to the field of engineering, offering spatially referenced information for a multitude of applications (7 Mile Advisors 2017). Today, the geomatics industry is constantly changing, complementing more than just engineering, but also law enforcement, artificial intelligence, aerospace, defense, etc. (7 Mile Advisors 2017). The substantial growth within the discipline and spillover to other industries can be attributed to the high degree of innovation and adaptation of new geospatial technologies. This innovation and industry growth has attracted investment and created a highly competitive business environment, resulting in increased activity in the geomatics industry (7 Mile Advisors 2017).

From analysis in this project, as shown in table 8 and table 9, surveyors in government institutions tend to receive a higher pay than those in private institutions carrying out similar job responsibilities. (However, based on information provided by GDOT, private S-G institutions specializing in transportation pay significantly more than GDOT for the typical S-G positions including Survey Technician, Rodman, Instrument Man, Party Chief and CADD Technician. Also, the variation of salary across rural versus urban areas of Georgia was noted.) The number of jobs for surveyors available when expressed as a percentage of the total jobs is slightly higher for government institutions than private surveying institutions.

Table 8. Snapshot: Private industry positions and corresponding salary ranges.

Position Title	Employers	Salary
Land Surveyor	Sunrise Engineering	\$30–\$42K
Professional Land Surveyor	OBEC Consulting Engineers	\$49–\$55K
Professional Surveyor	EMH&T	\$50–\$56K
Professional Land Surveyor	Davey Tree	\$50–\$56K
Solar Land Surveyor	Mortenson	\$45–\$55K
U.S. Survey (Civil)	Mortenson	\$37–\$45K
Dry Cargo Surveyor	Bureau Veritas	\$50–\$60K
Entry Level Surveyor	Dewberry	\$27–\$47K
Project Surveyor	David Evans & Assoc.	\$47–\$55K
Staff Surveyor	Surveying & Mapping	\$47–\$57K

Table 9. Snapshot: GDOT positions and corresponding salary ranges.

Position Title	Employers	Salary
Statewide Geodetic Supervisor	GDOT	$32–$57K
Computations Technician	GDOT	$27–$47K
Quality Assurance Supervisor	GDOT	$40–$71K
Survey Party Chief	GDOT	$29–$52K
Asst. SPC	GDOT	$27–$47K
Surveying Technician 2	GDOT	$24–$43K
Surveying Technician 1	GDOT	$22–$38K
Location Manager	GDOT	$40–$71K
Resident Survey Manager	GDOT	$32–$57K
Survey Data Specialist	GDOT	$29–$52K
Photogrammetry Technician 2 PGI	GDOT	$30–$52K
Photogrammetry Supervisor PGJ	GDOT	$33-$58K
Photogrammetry Lab Supervisor PGK	GDOT	$36-$63K
Photogrammetry Chief PGL	GDOT	$41-$72K
Photogrammetry Technician PGF	GDOT	$23-$38K
Photogrammetry Technician 1 PGH	GDOT	$27K-$48K

These snapshots represent random samples, and the information may not be an absolute representation of position availability and compensation for these positions. However, it provides an idea about the number of openings available in the private sector and government institutions in relation to compensation for the surveyors in the two institutions. It also reflects the interest of the government in S-G and emphasizes the fact that more attention should be paid to the private surveying industries in terms of job creation.

DEVELOPMENT OF SURVEYING–GEOMATICS POSITIONS MATRICES

The development of S-G employment positions matrices in this research project is aimed at investigating the current rate of job availability, to establish a connection between education levels in relation to job requirements. These matrices emphasize the importance of licensure and demonstrate the minimum requirement to be eligible for certain roles in both public and private survey organizations.

The matrices formed in this task were intended to show that as the hierarchy of the job position increases, the education and skill requirement for that position also increases. They also show how position structure in an organization increases with increasing educational requirements.

In Georgia, the Georgia Department of Transportation, SAMSOG, and other stakeholders have been consistently trying to increase the surveying–geomatics student enrollment and, consequently, increase the surveying–geomatics jobs that are available in Georgia for new graduates and non-traditional students.

In the development of the first matrix, the research team examined the positions available at the surveying unit (all departments) of GDOT and some other states across the United States. For the second matrix, the team examined positions available at the California Department of Transportation. Caltrans was selected because it is the most viable transportation system in the United States and among the largest employers of surveyors in the transportation industry in the U.S. Similarly, for the development of the third matrix, the researchers conducted a random sampling of surveying–geomatics positions available in the State of California. The decision to use California as the benchmark was based on the robust nature of the transportation system in California and to be able to directly relate it to that of Caltrans for comparison purposes. The idea was to use the state of employment availability as a reference to check the current availability of positions in Georgia. These matrices have been systematically arranged in the order of hierarchy from the top-level to the entry-level positions.

Some of the key descriptive attributes that characterized the columns in the matrices include:

- Position title.
- Type of setting (public or private).
- State and city of the open position.
- Name of employers.
- Work location (field/office/combination).
- Education requirements for that position (associate degree, BS, MS, PhD, or other).
- Number of years of experience required.
- Software/geospatial experience required for the position.

Other attributes include:

- Name of the employer department.
- Licensure required (to be eligible for the position in this column).
- Experience requirement (either in-house experience or outside the organization).
- Work description (management/production/combination).
- Surveying–geomatics software experience.
- Salary for the position.
- Medical benefits associated with the position.
- Retirement benefit.

Table 10 shows some of the key descriptive attributes used in generating the first matrix. A total of 62 position were examined and detailed out to generate the first matrix. The full matrix is attached in appendix D of this report.

Table 10. First matrix based on positions available at GDOT surveying unit and other states across the U.S. (Sources: Employment search engines at Monster.com 2021 and GDOT 2021)

Position Title	Public/Private	State/City	Employer	Field/Office	Education Requirements	Years of Experience	Geospatial/ Software
Senior Survey Technician	Public	Riverside, CA	County of Riverside	Comb.	BS	2–5	Y
Survey CAD Technician	Public	Colorado Springs, CO	Compass Surveying and Mapping, LLC	Office	BS	5–10	Y
Geospatial Data Manager	Public	Tulsa, OK	US Army Corps of Engineers	Comb.	BS	2–5	Y
GIS Technician	Public	Hinesville, GA	City of Hinesville	Office	BS	2	Y
GIS Intern	Public	Sandy Springs, GA	City of Sandy Springs	Office	BS	0	Y
GIS Specialist	Public	Oconee County, GA	City of Oconee	Office	BS	1	Y
Project Surveyor	Public	Mentor, OH	CT Consultants	Comb.	AS/BS	5–10	Y
Right of Way Officer	Public	Grand Fork, ND	Grand Fork	Field	AS/BS	2	Y
Professional Land Surveyor	Private	Des Moines, IA	HR Green	Comb.	BS	5	Y
Location Bureau Chief	Public	Atlanta, GA	GDOT	Comb.	NA	7	Y

BS = Bachelor of science; AS = Associate of science; NA = Not applicable

Similarly, the second matrix was formed from positions available at the Caltrans website; the key descriptive attributes are as shown in table 11. A total of 14 positions were extracted for analysis. The full matrix is provided in appendix E of this report.

For the third matrix, a total of 30 randomly sampled surveying–geomatics jobs were generated from the web search, and the key descriptive attributes used in generating the matrix are as shown in table 12. The full matrix is attached as appendix F in this report.

After generating the three matrices, it was important to sort the matrices into categories that can aid the analysis and for validation purposes. The matrices were sorted into two categories. One of the categories was based on the positions obtained from GDOT and the other was categorized by the Georgia Southern University (GSU) research group based on the analysis of the requirements and some other observation of these positions.

The positions in the three generated matrices fell into either of the two groups. There were six categories for the GDOT classification and five categories according to the GSU research group classification, as shown in table 13 and table 14.

Table 11. Second matrix based on surveying-geomatics positions available at Caltrans. (Source: Jobs website, Caltrans 2021)

Position Title	Public/Private	State/City	Employer	Field/Office	Education Requirements	Years of Experience	Geospatial/ Software
Party Chief	Public	Sacramento, CA	Caltrans	Comb.	BS	NA	Y
Transportation Surveyor	Public	Santa Clara, CA	Caltrans	Office	BS	NA	Y
Transportation Surveyor	Public	Alameda, CA	Caltrans	Office	BS	NA	Y
Transportation Surveyor	Public	Stockton, CA	Caltrans	Office	BS	NA	Y
Transportation Surveyor	Public	Fresno, CA	Caltrans	Office	BS	NA	Y
Transportation Survey Party Chief	Public	Bishop, CA	Caltrans	Field	NA	NA	N
Transportation Survey Party Chief	Public	Shasta, CA	Caltrans	Field	NA	NA	N
Transportation Surveyor	Public	Bishop, CA	Caltrans	Field	NA	NA	Y
Project Surveyor	Public	Marysville, CA	Caltrans	Field	NA	NA	Y
Transportation Engineering Tech.	Public	Riverside, CA	Caltrans	Field	NA	NA	N

BS = Bachelor of science; NA = Not applicable

Table 12. Third matrix based on surveying-geomatics positions available in California. (Sources: Monster.com 2021 and ZipRecruiter 2021).

Position Title	Public/Private	State/City	Employer	Field/Office	Education Requirements	Years of Experience	Geospatial/ Software
Land Surveyor	Private	California City, CA	GPAC	Office	NA	5	Y
Land Surveyor	Private	Eureka, CA	Omsberg & Preston	Comb.	NA	2	Y
Asst. Land Surveyor	Public	Sacramento, CA	Sacramento County	Field	BS	1	Y
Land Surveyor	Private	Los Angeles, CA	KPFF	Field	NA	0–3	NA
Project Surveyor	Private	Santa Clarita, CA	David Evans & Assoc. Inc	Comb.	NA	NA	Y
Land Surveyor	Private	Roseville, CA	Evolvinc	Comb.	NA	5	Y
Asst. Land Surveyor	Public	San Diego, CA	City of San Diego	Field	BS	NA	Y
Principal Survey Aide	Public	San Diego, CA	City of San Diego	Field	BS	NA	Y
Survey Associate	Public	San Francisco, CA	San Francisco	Field	NA	NA	Y
Land Technician	Private	San Francisco, CA	Pacific Gas & Electric Company	Comb.	NA	NA	Y

BS = Bachelor of science; NA = Not applicable

Table 13. Classification from GDOT positions.

Positions	Categories
Location Bureau Chief	GDOT-SG 01
Engineering Operations Manager	GDOT-SG 02
Assistant CCS **Consultant Compliance Supervisor** **Quality Assurance Supervisor** **Statewide Cadastral Supervisor** **Statewide Geodetic Supervisor**	GDOT-SG 03
Statewide Survey Data Specialist **Asst. Statewide Survey Data Specialist** **Photogrammetry Technician 2 PGI** **Photogrammetry Supervisor PGJ** **Photogrammetry Lab Supervisor PGK** **Photogrammetry Chief PGL** **Photogrammetry Technician PGF** **Photogrammetry Technician 1 PGH**	GDOT-SG 04
Surveying Technician 2 **Surveying Technician 1** **Computations Technician**	GDOT-SG 05
Survey Party Chief (SPC) **Asst. SPC**	GDOT-SG 06

Table 14. Classification formed by Georgia Southern University research group positions.

Positions	Categories
Entry Level	GSU-SG 01
Crew Chief **Survey crew chief** **Transportation Survey Party Chief**	GSU-SG 02
Survey Technician **Land Technician** **Transportation Surveyor** **Survey CAD Technician** **Land Surveyor** **Asst. Land Surveyor** **Office/Associate Surveyor** **Professional Land Surveyor**	GSU-SG 03
Survey Manager **Location Manager** **Resident Survey Manager** **Geospatial Data Manager**	GSU-SG 04
GIS Specialist **Survey Data Specialist** **GIS Technician** **GIS Programmer** **Right of Way Officer**	GSU-SG 05

NOTE: The classification is not a full description of these positions, as they were created for sorting purposes in this research and to reflect the nature of surveying–geomatics jobs in Georgia when compared to that of California. The classification presents groups of positions that fall under similar responsibilities as closely as possible.

After sorting the positions into the two categories that were established from the GDOT classification and the Georgia Southern University research group, the results of the first matrix were summarized, as presented in table 15.

Table 15. Percentage for GDOT and GSU classifications for positions in GDOT and the U.S.

Classification	GDOT-SG (%)	GSU-SG (%)
1	2	3
2	8	21
3	11	47
4	11	16
5	50	13
6	18	

Shading = Not applicable

The results of the analysis obtained from the first matrix according to the GDOT classification show that most of the roles at GDOT are concentrated in class 5, with the highest number of openings for survey technicians. This means that the job openings at GDOT are more concentrated in surveying technician and computation technician roles but are lagging in the entry-level positions. The results according to the GSU research group classification show that GIS-related roles are very low at GDOT when compared to Caltrans. They also show fair distribution of positions in classes 3 and 4, which means the availability of positions for statewide data analyst, land surveyor, consultant compliance supervisor, and others in this class have above average availability.

The results after sorting into the two classes for the second matrix are presented in table 16.

Table 16. Percentage for GDOT and GSU classifications for positions at Caltrans.

Classification	GDOT-SG (%)	GSU-SG (%)
1	–	–
2	14	14
3	50	64
4	–	21
5	18	–
6	14	

– indicates none; shading = not applicable

The result of the analysis of the second matrix according to the GDOT and GSU research group classifications shows that most of the positions available at Caltrans fall into class 3. This means there are excess positions open for the transportation surveyor role, with the majority being supervisory and managerial roles. Even though both GDOT and Caltrans have low numbers of entry-level positions, an appreciable number of positions are open in classes 3 and 4, which includes transportation surveyor and land surveyor roles, at GDOT when compared to that of Caltrans.

The results obtained after sorting into the two classes for the third matrix are presented in table 17.

Table 17. Percentage for GDOT and GSU classifications for positions in California.

Classification	GDOT-SG (%)	GSU-SG (%)
1	–	–
2	4	–
3	13	76
4	27	24
5	17	–
6	–	

– indicates none; shading = not applicable

The results show a significantly low availability of entry-level surveying positions in California and a fair number of openings in classes 4 and 5, which include land surveyor and project surveyor roles. California has a lower rate of class 6 roles, which include survey party chief and assistant SPC roles, when compared to those available at GDOT. The results also show that Georgia has more surveying and computation technician roles and slightly higher surveying manager roles than California.

CONSULTATION AND VALIDATION OF S-G POSITIONS MATRIX

To demonstrate that the matrices created in this research project are on the right path, a brief questionnaire was issued to the surveying–geomatics professionals in the Georgia Department of Transportation. Their responses were used to further establish the concepts of this research work. To facilitate the survey, four validation questions were written and sent out to the participants to choose from two options; they were also allowed to express their opinion about each question. The survey questions, predominant answers from GDOT’s correspondent, and the most prominent opinions on each question are presented below.

The first question was aimed at confirming if the percentage of S-G position availability in government and private institutions was true, as asked in the survey. It was as follows:

> *"From analysis, 61% and 39% of surveying jobs are from public and private organizations respectively, do you think public organizations have more S-G positions and employing power than private organizations."*

The validator of this question thought that most surveying positions are at private companies because GDOT sends out most of the survey work to consultants. Thus, the professional does not agree with the finding that jobs in surveying–geomatics are predominantly from public institutions because these public institutions award most surveying jobs as contracts to the private surveying companies.

The second question was to establish the validity about the percentage of field to office positions in surveying–geomatics. The question was as follows:

> *"From analysis, 28% of the S-G positions are office based, about 28% are field based while 44% are combination of both field and office positions. Do you think most surveying jobs are predominantly focused on field and office location?"*

The GDOT validator for this question answered in the affirmative and thought lower-level positions are mostly field positions, but, as people move up the ladder, time is split between field and office. At the higher-level positions, people predominantly work in the office.

In the third question, the research team tried to explore the qualification most sought after by employers of surveyors. This question was as follows:

> *“From analysis, more than 90% of the S-G jobs require a minimum of bachelor’s degree qualification while very few require associate degree. Do you think bachelor is the most prevalent qualification for most surveying positions?”*

The GDOT professional believed only a few surveyors have bachelor’s degrees while many obtain more training and acquire more on-the-job training. The validator was also of the opinion that more people with bachelor’s degrees would be good to help with respect to other fields, higher pay, etc. This means the professional does not agree that a bachelor’s degree is the most prevalent qualification of most surveyors.

Similarly, the fourth question was developed to expound on whether surveying–geomatics compensation (including benefits) is comparable in public and private organizations. The question was as follows:

> *“Do you think that surveyors in the public institutions get more benefits (health insurance, retirement benefits, etc.) than those in the private sector?”*

The professional believed compensation is often based on the number of years of experience, education level, and the skills of the surveyor involved, and it largely depends on the nature of the work being done by the surveyor.

In summary, the feedback from the GDOT validator provided the research team with a general idea about the work structure in the surveying–geomatics industry. This information further helped in understanding job distribution. Finally, the feedback gave insight into the perception of professionals in the industry and was useful in the development of the project survey as well as questionnaires in future studies.

CHAPTER 4.
TASK 3: DEVELOPMENT OF SURVEYING–GEOMATICS EDUCATION/SUBJECT COVERAGE MATRIX

LITERATURE REVIEW

Similar to many other countries, the United States follows a tradition in the surveying and geomatics profession that does not necessarily require a four-year bachelor's degree to qualify (depending on the state) as a land-surveyor-in-training or as a professional land surveyor (PLS). Rather, the S-G licensure system is rooted in a form of apprenticeship. Interested pupils are educated by educational institutions that introduce the theoretical percent computational aspects of the discipline and are later trained under the supervision of a PLS who exposes them to the state law and professional practice. But this profession is not limited to fundamental education and apprenticeship only, which is the minimum requirement; many professional surveyors (e.g., in Georgia) qualify with a four-year bachelor's degree or more. Even PhD-credentialed professionals are now involved in this profession as specialists, researchers, and educators.

With the currently decreasing numbers of surveying professionals and the intrusion from other professionals of related emerging technologies, key authors as proposed by the NSPS have defined the surveying body of knowledge to clarify the scope of the surveying–geomatics profession (Bethel 2011; Greenfield 2011a, 2011b; Lathrop 2011; Lathrop and Lucas 2011; Paiva 2011). Moreover, the orientation of new technologies, as well as the presence of professionals, specialists, and researchers, brings about new challenges in this field of knowledge, which necessitates the continual modification of the SBoK. One of the most important implications of the SBoK is that it outlines the formal educational requirement and knowledge areas, which include both the theoretical know-why and the application of know-how in the professional area (Greenfield 2011b). The SBoK identifies that this profession requires five specific fields of knowledge, i.e., positioning, imagery, GIS, land development, and law, from the U.S. perspective. On the other hand, the Engineering Accreditation Commission (EAC) and the Applied and Natural Science Accreditation Commission (ANSAC) of ABET control the minimum requirements to achieve the objectives and outcome of overall college-level surveying–geomatics education (Greenfield 2011b). Though NCEES prefers surveying core programs accredited by ABET, the S-G programs in the non-traditional pathway must also be considered for evaluating the applicants (NCEES 2020).

In light of this, the seven outcomes required by ABET are a standard way of developing the education curriculum (ABET 2021). These outcomes are summarized in figure 2. ABET also sets the program criteria for the engineering program that includes surveying–geomatics in the title, and it sets forth the curricula to include the following (ABET 2021):

a. "*Mathematics, including statistics, to support analyses of complex surveying/geomatics problems;*

b. *Historical and legal elements of land ownership, particularly where surveying/geomatics are an integral part;*

c. *Data science and analysis for conformance of precision/accuracy;*

d. *Data structure/format, storage/management, publication/visualization, and the related legal responsibilities to the public;*

e. *Modern measurement and design technologies necessary to model, locate or construct features above, below or on the Earth's surface.*

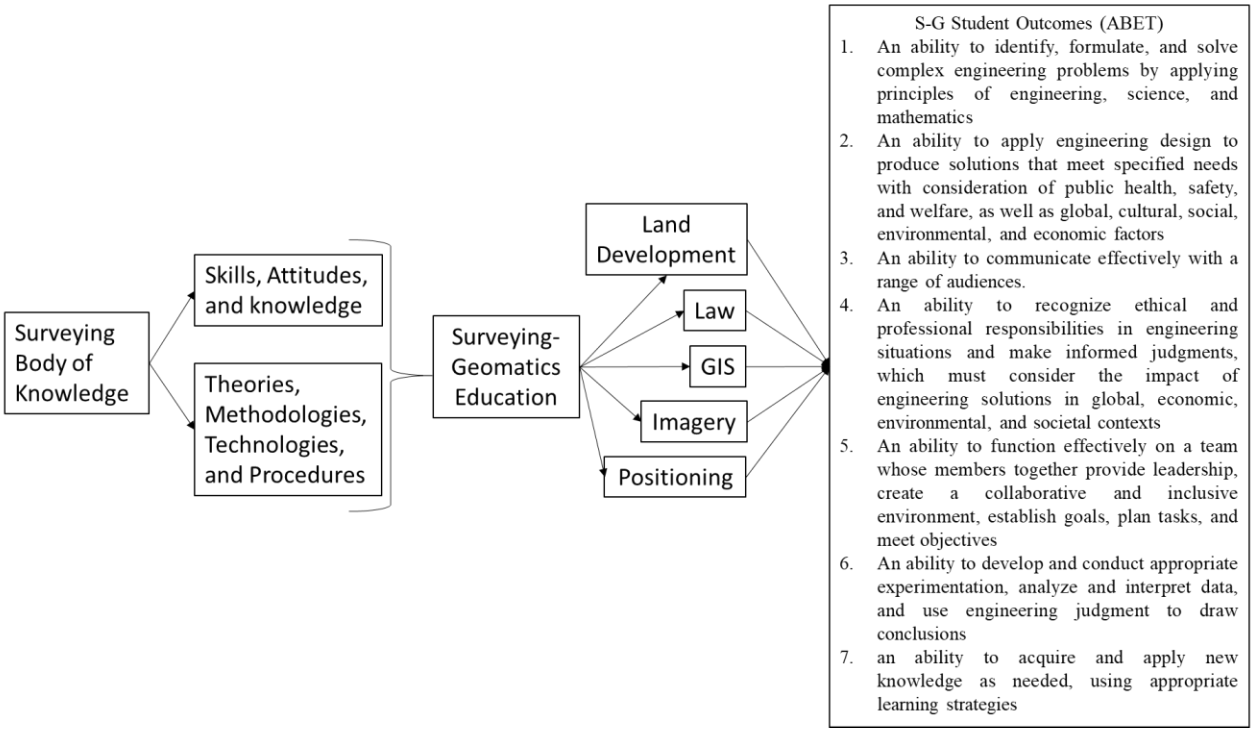


Figure 2. Diagram. Relationships between SBoK, surveying–geomatics education, and ABET outcomes. (ABET 2021)

f. Added depth in a minimum of four subject areas, consistent with the program's educational objectives, chosen from the following:

- *boundary and/or land surveying*
- *engineering surveys*
- *photogrammetry and remote sensing*
- *geodesy and geodetic surveying*
- *mapping including map projections and coordinate systems*
- *geospatial data science and land information systems*
- *civil engineering topics that assist the student in meeting the requirements for licensure in the state or region."*

The knowledge areas and the specific fields under those knowledge areas are outlined in figure 3 (Greenfield 2011b). These specific fields of knowledge match the program criteria set by ABET.

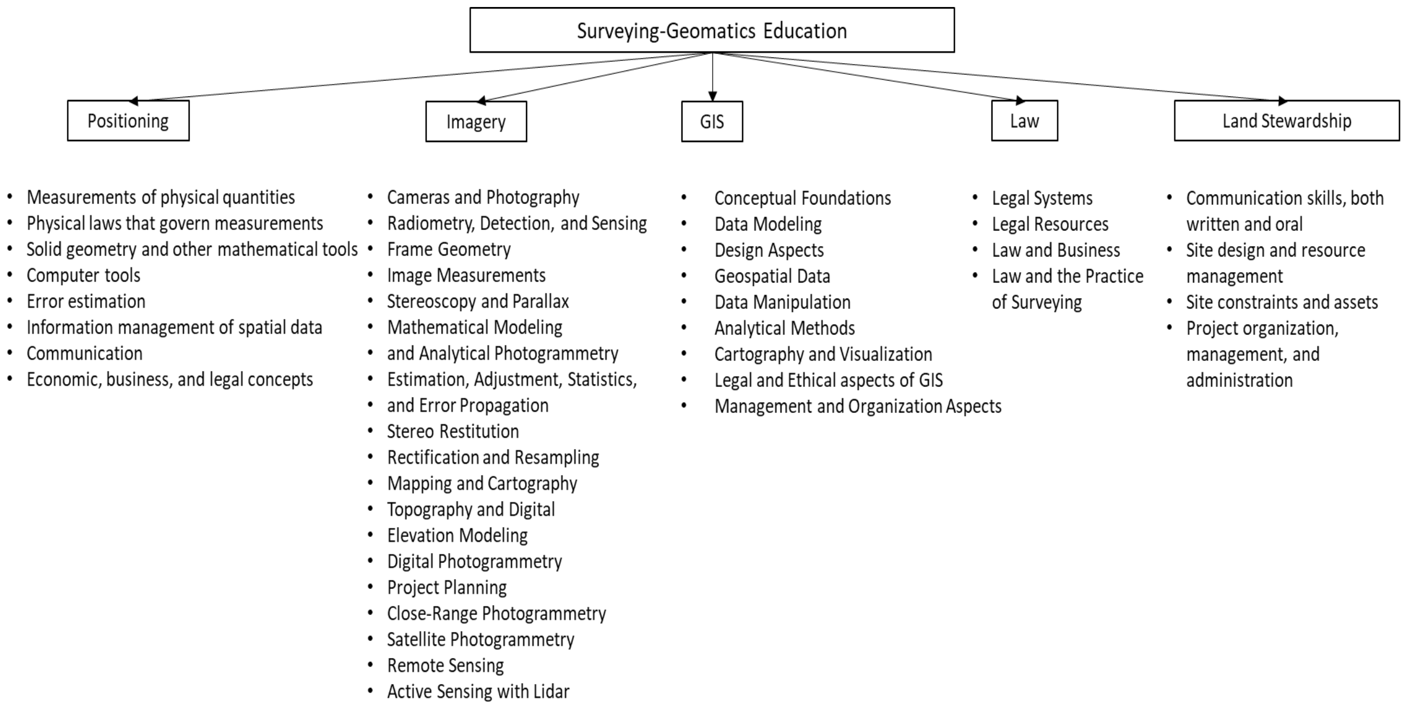


Figure 3. Diagram. Surveying–geomatics education knowledge areas. (Greenfield 2011b)

Based on the level of competency and knowledge, the SBoK divides professionals into three categories, i.e., general practitioners, specialists, and scholars, where individuals have different contributions over the professional area (Greenfield 2011b). The general practitioner “performs routine surveying tasks such as boundary surveying, construction surveying, and other standard mapping tasks” (Greenfield 2011b). The specialist “serves as an expert witness in court, a surveyor who performs high accuracy deformation surveys and analysis, a surveyor who specializes in image analysis, or a surveyor who designs and manages GIS systems” (Greenfield 2011b). The scholar has “the competency level of becoming an educator in S-G academic programs or a faculty member in the university or a member of a hardware/software company, who conducts research on specialized fields and contributes to the state of the art of S-G industry" (Greenfield 2011b). The body of knowledge also set the preference of educational requirements for this level of expertise, which is summarized in table 18.

Table 18. Educational requirements for surveyors. (Greenfield 2011b)

Area of Education	Level of Competence	Undergraduate Degree	Professional Education	Post Baccalaureate Certification	Graduate Degree
GIS Education for Surveyors	General Practitioner	R	R	P	–
	Specialist	R	R	R	P
	Scholar	R	P	P	R
Knowledge for Positioning Competency	General Practitioner	R	P	–	–
	Specialist	R	R	P	–
	Scholar	R	P	P	R
Photogrammetry[1]	General Practitioner	R	R	–	–
	Specialist	R	P	P	P
	Scholar	R	P	–	R
Legal Knowledge[2]	General Practitioner	R	R	–	–
	Specialist	R	P	–	–
	Scholar	R	–	P	–
Land Stewardship[3]	General Practitioner	R	R	P	–
	Specialist	R	P	–	–
	Scholar	R	–	–	P

[1] Authors of this report identify the best educational preference for Photogrammetry.
[2] Authors of this report identify the best educational preference for Legal Knowledge.
[3] Authors of this report identify the best educational preference for Land Stewardship.
R = Requires; P = preferred; – indicates not applicable.

In short, it can be deduced that SBoK, NSPS, NCEES, and ABET are on the same page in defining the scope and outcomes, as well as setting the educational program of the S-G profession. These guidelines directed the researchers in the current study in developing a 'technology and time' adaptive, focused, and applicable education model structure in Georgia that will be convenient for interested pupils and increase enrollment in this profession.

INVESTIGATION OF SURVEYING–GEOMATICS IN THE U.S. AND OTHER DEVELOPED COUNTRIES

This section of the report investigates the education requirements for a PLS in the United States, Canada, Australia, and South Korea. Selections of these countries were made for the following reasons. Canada shares a border with the U.S. and has a comparable standard of education. Licensure procedure in Western Australia is standardized in both Australia and New Zealand, which seems a good sample for the Australian region. South Korea is also a well-developed country in the Asian region, and the professional engineering as well as the professional surveyor licensing procedures are well established in that region. Moreover, the necessary data of these countries are readily available on the Internet, and offer incentive for choosing these countries. This comparative section examines the relative licensure procedures of these countries and provides a comparative evaluation of the U.S. standard.

United States

The National Society of Professional Surveyors is currently the primary S-G society in the U.S. This society is solely responsible for establishing the common interests, objectives, and political efforts that would help bind the surveying profession into a unified body (Purcell 2014). As indicated in chapter 2 of this report, on October 24, 2014, by the vote of its board of directors, NSPS education policy was modified to require a “Bachelor’s Degree in Surveying, Surveying Engineering, or Surveying Engineering Technology” (NSPS 2014). However, this regulation is not always applied in all states in the U.S. For example, the state of Georgia requires applicants to complete 18 semester hours of courses that meet specific criteria (see chapter 2 of this report). The progression in the S-G profession, along with the education and licensing requirements, are outlined in figure 4. In the state of Georgia, an applicant can become a PLS with successful completion of a college or university degree (i.e., traditional pathway) or a certificate program (i.e., non-traditional pathway) and achieve required coursework that meets criteria needed to satisfy the 18-semester-hour requirement. This requirement is set forth by the Georgia Board of Professional Engineers and Land Surveyors (Georgia Secretary of State 2018b) In summary, with an ABET-accredited bachelor's degree and the completion of a minimum of 18 semester hours of required courses (which may or may not be included in the bachelor's curriculum), an applicant can become a PLS, as well as a professional engineer (PE). With the completion of a master's degree and a PhD, an applicant can become a PLS, PS, educator, and researcher in the S-G profession.

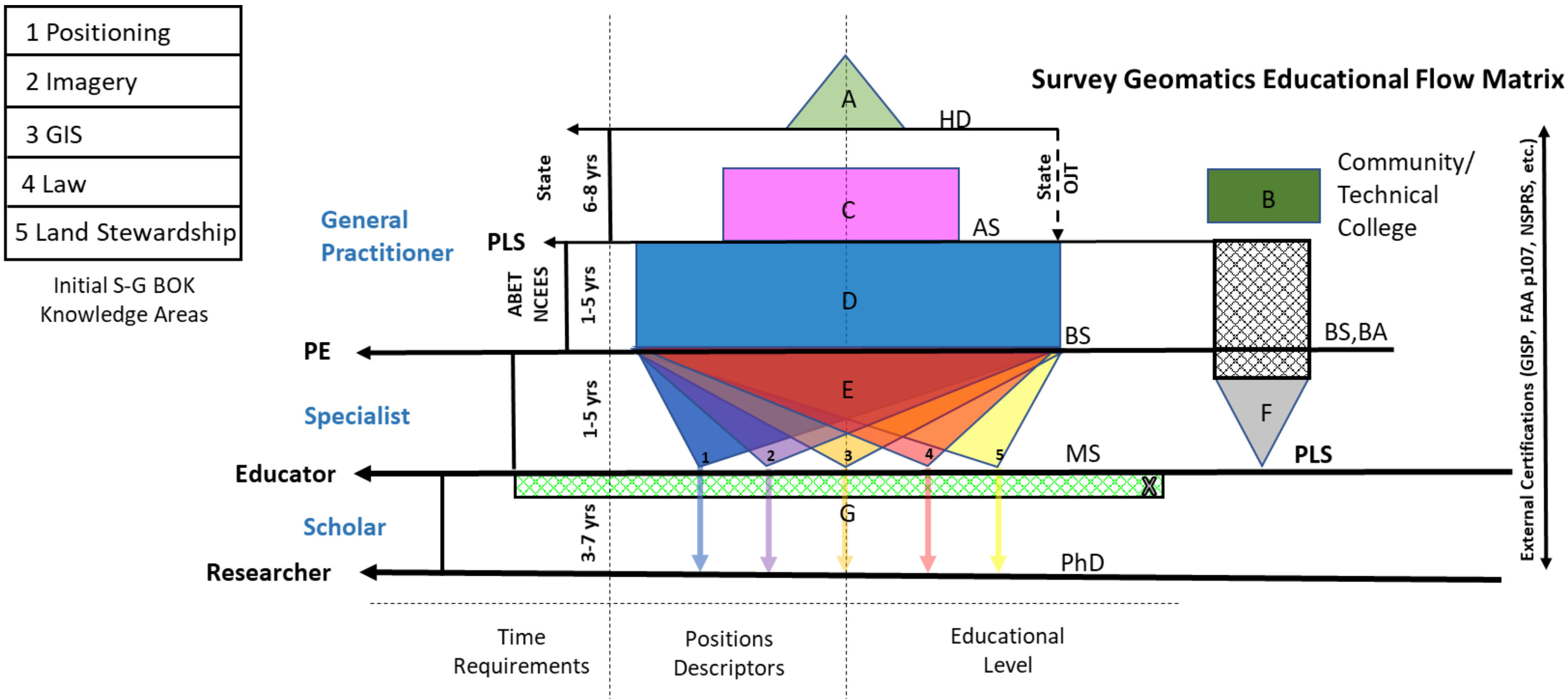


Figure 4. Flow chart. Opportunity and education on surveying–geomatics in Georgia. (Flowchart courtesy of Brad Clement, developed in July 2019, MS student of the Department of Civil Engineering, Georgia Southern University)

Canada

In Canada, the professional licensure procedure is regulated by the 10 individual provinces, dependent on where the applicant wishes to work. However, if a practitioner wishes to work anywhere within Canada (i.e., multiple provinces), a license is required from the Association of Canada Lands Surveyors (ACLS 2021). Even though each association has its process and criteria, they have some common ground among them, such as obtaining the equivalent of a university degree in geomatics engineering, similar experience requirements, and working under the supervision of a PLS. Three organizations in Canada that evaluate the applicant's academic achievement include: (1) for the province of Quebec, the *Ordre des arpenteurs-géomètres du Québec* (OAGQ) Board of Examiners; (2) for Ontario, the Association of Ontario Land Surveyors (AOLS); and (3) for all other parts of Canada, the Canadian Board of Examiners for Professional Surveyors (CBEPS). The evaluation indicates the items in the syllabus that the applicant needs to complete to fulfill the academic requirements. An applicant can then complete these items by taking further courses or writing syllabus examinations. On the other hand, applicants having non-traditional academic preparation or at least the equivalent to a two-year geomatics program at a technical institute or college may apply for an individual evaluation, and the evaluation will indicate which of the items in the syllabus must be completed to fulfill the academic requirements. The requirements of core subjects and elective subjects are summarized in table 19. The procedure of licensing as a PLS in Canada combines educational background with apprenticeship, which seems very similar to the system followed in Georgia, except in Canada the generalized licensing process is controlled by the Board of Registrar countrywide (CBEPS 2019).

Table 19. Required course criteria covered in Canada for PLS license. (CBEPS 2019)

Course Type	Course Title
Core Subjects: (mandatory subjects)	C1 – Mathematics
	C2 – Least Squares Estimation & Data Analysis
	C3 – Advanced Surveying
	C4 – Coordinate Systems & Map Projections
	C5 – Geospatial Information Systems
	C6 – Geodetic Positioning
	C7 – Remote Sensing & Photogrammetry
	C8 – Cadastral Studies
	C9 – Survey Law
	C10 – Land Use Planning & Economics of Land Development
	C11 – Business Practices & the Profession
	C12 – Hydrography
Elective Subjects: (one of the four elective subjects)	E1 – Spatial Databases & Land Information Systems
	E2 – Advanced Hydrography
	E3 – Environmental Management
	E4 – Advanced Remote Sensing
	E5 – Advanced Photogrammetry

Australia

The Land Surveyors Licensing Board of Western Australia requires the new applicant to hold a four-year bachelor of surveying degree from a University, complete a two-year professional training agreement (PTA) with a licensed surveyor, complete five projects, and sit for a series of practical and written assessments to be eligible for application (Land Surveyors Licensing Board of Western Australia 2020). The flowchart in figure 5 shows the steps for PLS licensure in Australia.

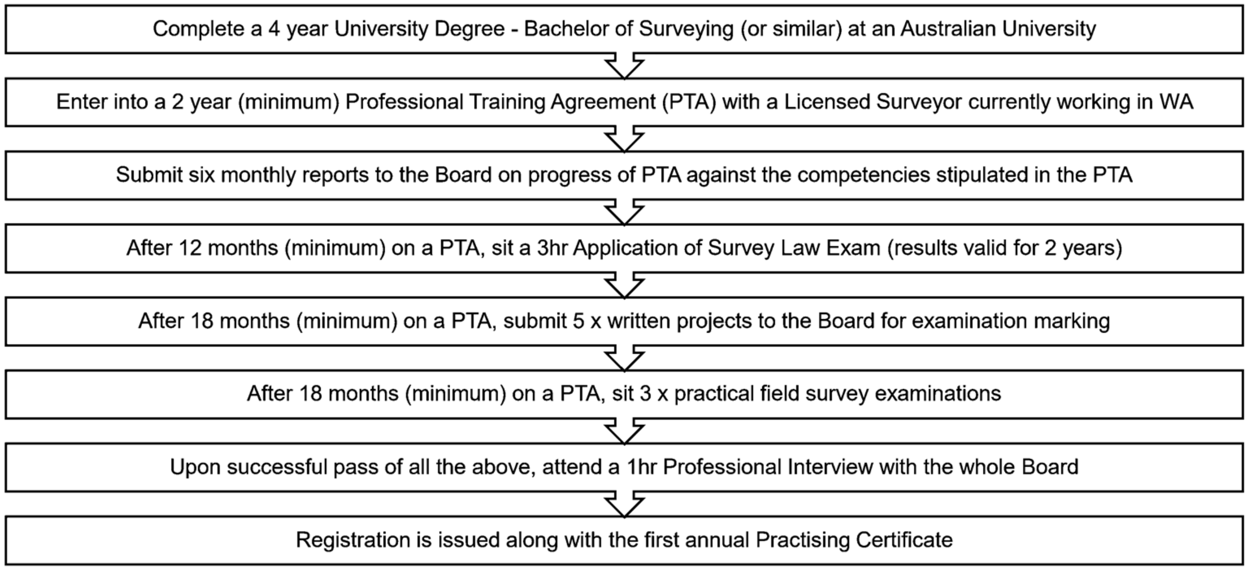


Figure 5. Flowchart. Steps for PLS licensing in Australia.
(Land Surveyors Licensing Board of Western Australia 2020)

South Korea

In South Korea, there is no additional course requirement to be a land surveyor. For civil engineering students, the qualifications to become an engineer in training (EIT) or an LSIT (which are Engineer in Civil Eng. or Engineer in Surveying Geo-Spatial Information, respectively) are the same. Four levels of license are available for engineers with different educational requirements:

1. Craftsman requires graduation from any technical high school.
2. Industrial Engineer requires an associate's degree or 2 years in college education.
3. Engineer requires graduation from college (BS or BE).
4. Professional Engineer requires a BS or BE in Engineering.

Moreover, South Korea has two licenses relevant to surveying–geomatics: (1) EIT and PE licenses in both Surveying Geo-Spatial Information, and (2) Cadastral Surveying.

Next Steps for Georgia

Based on these comparisons, the licensure procedure for PLS in the state of Georgia is similar to other countries in the world, though there is some contradiction with the NSPS' new education policy. Next, it was important to evaluate the adequacy and availability of educational institutes and educators in Georgia. A comprehensive education matrix would illustrate the existing education structure in Georgia. Even though the professional practice and PLS licensing procedures are similar across different geographical locations, the number of professionals in this field is decreasing and a reason for this may be the system based on place-specific, inconvenient education facilities. In the next section, the research team developed an education matrix to explore this issue.

DEVELOPMENT OF AN EDUCATION MATRIX

A key part of this research was to develop an education matrix that would be used to evaluate the existing S-G education system in Georgia and help bridge the gap between requirements in adjoining states. Also, this matrix would reflect the capabilities of Georgia's educational institutes to meet the requirements set by the Georgia Board of Professional Engineers and Land Surveyors.

One of the purposes of this research was to evaluate and provide a viable solution to the lack of S-G education availability for place-bound students and traditional residential students, and the associated lack of availability of new employees and existing GDOT personnel who are properly educated in the S-G profession. The education matrix would help pinpoint the areas where improvements are necessary.

In Georgia, the Surveying and Mapping Society of Georgia is the current statewide professional organization for the surveyor. This society is trying consistently to strengthen and refine the surveying profession through the Georgia State Legislature, the State Board of Registration for Professional Engineers and Land Surveyors, and other professional groups, such as the NCEES, and through academic input at various schools. SAMSOG identifies three universities and two technical colleges in Georgia that are capable of providing prerequisite education for licensure (SAMSOG 2020). Athens Technical College offers less than 18 semester hour courses in S-G–related fields, so it was not included in the education matrix; however, the four schools offering degrees, specializations, or certification programs were included in the matrix: (1) Kennesaw State University (KSU 2021), (2) Georgia Southern University (GSU 2021a), (3) University of North Georgia (UNG 2021), and (4) Albany Technical College (ATC 2021).

The information about the courses included in the matrix was collected from the course-offering portal of each school (UNG 2021, GSU 2021b, KSU 2021, ATC 2021). The detailed matrix is provided in appendix G. The key course information shown in the 13 columns of table 20 is described (by column number) as the following:

(1) **Ser (Serial Number)** indicates the sequence of the courses.

(2) **Course Prefix/ Number** represents the level of course, e.g., whether the course is 2000 level, 4000 level, or 5000 level.

(3) **Course Name** indicates the title of the course.

(4) **University/College** indicates the school name.

(5) **Semester** for this study included Fall 2019, Spring 2020, Summer 2020, Fall 2020, Spring 2021, Summer 2021, and Fall 2021.

(6) **Section** provides the number of sections of the course. Sometimes the sections are identified as *online* or *face to face*. This column entry how frequently the school is offering the course, as well as the setting in which the students are receiving the benefits of it.

(7) **Credits** records the credit hours of the offered course.

(8) **Lab Required** denotes if the course requires additional laboratory work or not.

(9) **Face-to-Face**, **Online**, or **Hybrid** in column (9) denotes the mode of class conduct, for which the different letter designations on the same course distinguish sections as face-to-face, online, or a combination.

(10) **Synchronous** and **asynchronous** indicates a strict class schedule for a class that is synchronous versus time flexibility for one that is asynchronous.

(11) **Enrolled** provides the number of enrolled students in the course in the stated semester. This column is indicative of the number of potential candidates for S-G–specialized participants, as well as professionals in the future.

(12) **GA BOR Course Designation** provides the course categorization from **S1** to **S5+** based on the outlines and syllabus prescribed by the Georgia Board of Registration for Professional Engineers and Land Surveyors.

(13) **Instructor** provides the course instructor's last name, which is an indication of available instructors in the stated course. This information is collected from individual university course-search and course-offering portals.

The orange-colored rows in the education matrix in appendix G represent the courses that are included in the university course catalog but were not offered within the study time frame.

Table 20. Table heading of the S-G education matrix.

(1) Ser	(2) Course Prefix/ Number	(3) Course Name	(4) University/ College	(5) Semester	(6) Section	(7) Credits	(8) Lab Required	(9) O=Online, F=Face-to-Face, H=Hybrid	(10) S=Synchronous, A=Asynchronous	(11) Enrolled	(12) GA BOR Course Designation (S1–S5+)	(13) Instructor

The four schools included in the matrix currently offer the following programs:

- KSU offers surveying courses under its BS in geospatial sciences and a GIS certificate through its Department of Geography and Anthropology within the Norman J. Radow College of Humanities and Social Sciences. Also, some fundamental courses are offered under the KSU Department of Civil Engineering within the Southern Polytechnic College of Engineering and Engineering Technology (KSU 2021).
- GSU offers S-G courses in a "non-traditional pathway" and under the BS and MS in civil engineering, the BS in construction engineering, the BS in construction management, and the Accelerated Bachelor's Master's (ABM) program in the Department of Civil Engineering and Construction (GSU 2021b).
- UNG offers S-G courses under the BS in environmental spatial analysis; AS in geospatial engineering technology; and graduate certificate in land surveying, geospatial science and technology, and geomatics in the Lewis F. Rogers Institute for Environmental and Spatial Analysis (UNG 2021).
- ATC offers S-G courses under an AAS with an engineering–surveying specialization (ATC 2021).

The education matrix shows that the scope is limited for students who desire to specialize in the S-G profession to utilize the educational institutions in Georgia, as only four institutions are offering the full package required for PLS licensing. However, some of the institutions are offering asynchronous and flexible online courses that are appropriate for distance learning. This format helps future Georgia surveyors in enrolling in the S-G courses. Thus, it is important to identify the students' perception about the convenience of the education facilities in Georgia, as well as estimate the available infrastructure, capability, funding, and facilities available in these institutes.

CONSULTATION AND VALIDATION OF S-G EDUCATION MATRIX

For validation of the research progression for this surveying–geomatics subject area matrix, a pilot questionnaire survey was executed by the leading S-G professional in GDOT, the results of which validate the progress of this study. The complete questionnaire is attached as appendix H. The questionnaire consisted of four questions, and in each question, four solutions were provided from which the participant could select, or had the option to write in comments. The participant was requested to rank the solutions from 1 to 5, where 1 indicates the highest priority and 5 indicates the lowest or no priority. These questions were developed focusing on issues such as how to reduce the diminishing participant interest in the S-G profession, how to increase their efficiency, and the availability of S-G educational institutes in Georgia.

The first question was about the enrollment of new and interested students in S-G courses in Georgia, and the question asked the responder to identify *"Creative methods to improve the enrollment of more students in the Georgia BORPELS' S1 to S5+ Surveying-Geomatics (S-G) courses."* The validator selected as his first ranking, "c) Stakeholders in the surveying profession should promote the profession and encourage the new generation," followed by, "a) Make a clear picture of the career plan among the potential students," "b) Make a foresight of the likely path the S-G profession will take in the near future," and, finally, "d) Target the college students with experimental marketing." This ranking indicates that the professional thought the best course of action would come from the S-G industry for creating the attraction among new students with promotional campaigns. Secondarily, the career goal and the correct path to becoming a PLS should be introduced to the new generations of surveyors. Finally, creative marketing should be started among college students to attract more inspired students to this profession.

The second question was a follow-up to the first question, as the researchers try to understand how to attract creative students in the S-G profession while experiencing reduced student enrollment. The question requested *"Methods to attract bright and creative students in the Geomatics field."* The validator thought that the S-G industry also has the priority role here and that more lucrative opportunities need to be created for students working under a PLS for training. Secondary to that, he thought that the educational institutes should come forth and increase the scholarships and create affordable admission requirements, increase the skill of instructors, and increase the extent and quality of lab facilities.

The third question was about the infrastructure of S-G education in Georgia. The question asked, *"How to focus the available resources to improve student learning in the most efficient way?"* in an effort to understand whether the industry thinks students' efficiency and ability is less than expected, and how and where to focus the funding to improve enrollment and student learning. The GDOT professional thought that the universities should be responsible to orient and make available the S-G education among different communities of learners as well as stakeholders. Also, he felt that an experimental and problem-based learning approach is an efficient way of improving student learning. The next priority approach was to use technologies, such as multimedia, animation, video conferencing, etc., as these would increase the optimum output from the students. Finally, he recognized that continuous updates of course curriculum and adaptation of new technologies in the syllabus would help the standardization of S-G education.

The fourth question was developed to understand the coordination between professionals, the S-G industry, and the students, and how to improve their relationship. The question asked for ways to *"Improve the collaboration between the potential students and professionals for better exposure to Geomatics as a profession."* The GDOT validator thought that a "mentoring program" would be the best way to create collaboration between students and professionals. The indicated next steps included providing school campus career talks, campaigns, and incorporation of professionals in the S-G academic courses. He identified that the introduction of the S-G profession in the civil engineering introductory course could enlighten students about this profession. The final selection was that the university should provide campus-based event marketing and advertisement by the industry contributors, as this would create insight among the students and, hence, the interaction would increase.

In short, the GDOT validator's observations and ranking gave the research team great feedback, and thus supported the direction being taken in this research. Before reaching out to widescale S-G professionals with an elaborate questionnaire survey to understand their perception, this provided an idea of some of the education enhancement possibilities and priorities that prevail in the S-G industry.

CHAPTER 5.
TASK 4: DEVELOPMENT, ISSUANCE, COLLECTION OF SURVEYING–GEOMATICS SURVEYS

DEVELOPMENT OF S-G SURVEYS: QUESTIONS

Overview

The research team developed survey questions intended to enhance the understanding of surveying–geomatics education in Georgia and help improve the quantity and quality of future surveying–geomatics education for the Georgia Department of Transportation and the State of Georgia. The survey contained a total of 37 brief multiple-choice questions with 14 of those questions requiring a short-written answer in part b. The questions were divided into four sections (Respondent Characterization, S-G Body of Knowledge/Skills, S-G Positions, and S-G Education Coverage/Needs) and it was estimated that the survey would take approximately 20 minutes to conscientiously answer all of the questions. A discussion of the question groups and/or the question purpose is presented in the following sections.

Section 1 of 4: Respondent Characterization

This section contained five questions, which were selected to establish some socioeconomic benchmarks to better understand the respondent group and to allow for some limited data mining in conjunction with the other groups of questions.

- Question 1 [1-01] *"What is your level of education?"*

  - Non-traditional pathway
  - Bachelor's degree
  - Master's degree
  - Doctoral degree
  - Other

  This question was designed to determine the breakdown of formal education level of the respondents and to allow for evaluation of association with other characterization and education variables/questions given in other parts of the survey.

- Question 2 [1-02] *"Do you specialize in any one area of Surveying–Geomatics? (i.e., Terrestrial Surveying or GPS Surveying or GIS or Mapping, etc.)."*

  - Yes
  - No

  This question was designed to determine whether respondents stick to one specialization within S-G and to allow for evaluation of association with other characterization and education variables/questions given in other parts of the survey.

- Question 3 [1-03] *"Are you employed by a public entity? (Federal, State or Local Government/Agency)."*

  - Yes
  - No

This question was designed to determine if respondents work for a public/government employer or in private industry within S-G and to allow for evaluation of association with other characterization and education variables/questions given in other parts of the survey.

- Question 4 [1-04] *"Are you a licensed Professional Land Surveyor in the State of Georgia?"*

  - Yes
  - No

This question was designed to determine if the respondent is a licensed professional surveyor to allow for grouping, and to allow for evaluation of association with other characterization and education variables/questions given in other parts of the survey.

- Question 5 [1-05] *"To estimate the economic impact of surveying in Georgia, the following ranges of annual salary are given. Please indicate your current range."*

  - $20K – $39K
  - $40K – $59K
  - $60K – $79K
  - $80K – $99K
  - $100K and over

This question was designed to determine the level of income of the respondent in order to estimate a statewide impact (based on median category values) and to allow for evaluation of association with other characterization and education variables/questions given in other parts of the survey.

Section 2 of 4: Surveying–Geomatics Body of Knowledge/Skills

This section of “ranking” questions allowed for grouping the 10 questions into 5 groups of 2 questions. Each two-question group evaluated that category against two considerations: (1) importance to the respondent’s daily operation, and (2) skill level for a newly licensed LSIT. Thus, within each of the five groups are subareas that were ranked accordingly. The five groups are: positioning, geospatial science, imaging science, land stewardship, and legal aspects. Question sets are given below.

Positioning

- Question 6 [2-01] *“Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying Geomatics?”*
- Question 7 [2-02] *“Based on your personal experience in Surveying–Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia?”*

Geospatial Science

- Question 8 [2-03] *“Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying–Geomatics?”*
- Question 9 [2-04] *“Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying–Geomatics, what order*

would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia?"

Imaging Science

- Question 10 [2-05] *"Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying–Geomatics?"*
- Question 11 [2-06] *"Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying–Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia?"*

Land Stewardship

- Question 12 [2-07] *"Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying–Geomatics?"*
- Question 13 [2-08] *"Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying–Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia?"*

Legal Aspects

- Question 14 [2-09] *"Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying–Geomatics?"*

- Question 15 [2-10] *"Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, based on your personal experience on Surveying–Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia?"*

Section 3 of 4: Surveying–Geomatics Position Questions

In this section, questions were developed with the intention of addressing the challenges associated with the availability and distribution of S-G positions in Georgia. The survey was aimed at understanding specific industrial requirements (e.g., the most extensive skillset being sought by employers, the educational qualification, etc.) and identifying techniques that will help to create more opportunities in the field of S-G. The researchers developed 10 questions with two or more choices and included a text box where participants could express their opinion about each question. The objective of developing each question is discussed below:

- Question 17 [3-01] *"From this analysis, the Bachelor of Science (BS) degree is the most prominent requirement for most S-G positions, do you think the BS requirement represents the minimum qualification of Land Surveyors in Georgia in the 21st century?"*

  This question was developed to determine what S-G professionals think the minimum most prevalent qualification is for most S-G roles at GDOT and at other private S-G companies in Georgia.

- Question 18 [3-02] *"Can the Surveying–Geomatics positions created by GDOT (Location Bureau Chief, Engineering Operations Manager, Assistant Consultant Compliance Supervisor, Consultant Compliance Supervisor, Quality Assurance Supervisor, Statewide Cadastral Supervisor, Statewide Geodetic Supervisor, Statewide Survey Data Specialist,* *Assistant Statewide Survey Data Specialist, Surveying Technician 2, Surveying Technician 1, Computations Technician, Survey Party Chief, and Assistant Survey Party Chief) be used as a tool to analyze S-G positions availability in Southeastern United States?"*

This question was developed to understand if respondents feel that the description hierarchy of S-G–related positions at GDOT can be used to analyze and compare against other states in the southeastern U.S.

- Question 16 [3-03] *"From this analysis, there is no detectable correlation between the Surveying–Geomatics positions available and the number of new surveying graduates. Do you think the number of available surveying jobs is not adequate for the number of yearly surveying graduates?"*

  This question was developed to understand the perception of S-G professionals, i.e., do they think that the number of available S-G positions in Georgia is sufficient to accommodate the numbers of new graduates.

- Question 19 [3-04] *"From this analysis, Professional Land Surveying licensure appears to be a very important requirement. Do you think having licensure improves the performance of surveyors on the job?"*

  This question was developed to investigate if respondents think that PLS licensure is improving the performance of surveyors on the job.

- Question 20 [3-05] *"From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Rank these groups in order of importance? (where 1st = Most Important Group)"* (In the order GIS, Remote Sensing, LiDAR, and Others.)

  This question was aimed at understanding the perception of respondents about the most important skillset needed by most S-G employers in order of importance/relevance.

- Question 21 [3-06] *"From our research, it is noted that students should be exposed to geospatial applications while in school to better prepare them for job opportunities upon graduation. Some of the means identified to accomplish this are listed below.*

  (a) *Including more geospatial courses in the curriculum.*

  (b) *Modifying/improving existing courses.*

  (c) *Other"*

  This question was intended to obtain ideas from respondents on the ways S-G students can be better prepared in the use of geospatial applications.

- Question 22 [3-07] *"Based on this analysis, the largest number of available positions in Surveying–Geomatics are in field operations. Do you think that most new Surveying–Geomatics jobs require mostly field work?"* (Options range from Strongly Agree to Strongly Disagree or Indifferent.)

  This question was developed to evaluate (from the respondents' point of view) if new S-G jobs require mostly field-based operations.

- Question 23 [3-08] *"From this analysis, most of the new S-G jobs reviewed require no in-house experience. Do you think this lack of in-house experience will impact the new employee's performance on the job?"*

  This question was developed to understand if respondents think that lack of in-house experience will impact the new employee's performance.

- Question 24 [3-09] *"Many of the S-G jobs require some number of years of prior experience. Do you think hiring should be based on the number of years of experience of the new employee?"*

  This question was developed to determine if respondents think that hiring new employees in S-G should be strictly based on the number of years of experience as opposed to allowing them to demonstrate their capability on the job.

- Question 25 [3-10] *"From this analysis, it is seen that the annual salary for S-G jobs ranges from \$22k to \$116k. In general, do you think that these salaries are large enough considering responsibility, education, and experience requirements for modern S-G positions?"*

  This question was developed to understand the perception of respondents about the salary range for land surveyors. That is, to investigate if respondents think that the current compensation range is enough considering the work responsibilities of surveyors.

The feedback from these questions will enable the research team to better understand the current S-G job availability, distribution, and the most sought-after requirements for most S-G professional positions. This understanding will ultimately provide guidance in giving recommendations to tackle the challenges of employment of S-G personnel and to help ensure a sustainable future of S-G professionals in Georgia.

Section 4 of 4: Surveying–Geomatics Education Coverage/Needs

The fourth section of the questionnaire survey was developed focusing on the educational status, needs, and requirements in Georgia. A total of nine questions were developed, which include the classification, performance, educational requirement, and ranking parts. In each question, the participant had the opportunity to express a personal comment, if so inclined. The reasoning for the questions is discussed below.

- Question 26 [4-01] *"Please rank the below pathways from best to worst regarding your perception on their adequacy/sufficiency to prepare students for the FS/PS exam?"* (Options of Completion of Certificate, Completion of BS, and Non-traditional learning)

  This question was developed to understand what the S-G professionals think about the three pathways to become a PLS in Georgia, i.e., the certificate program, the non-traditional program, and the BS program in the S-G field.

- Question 27 [4-02] *"Given your S-G experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field at the current levels of educational background?"* (Questions include knowledge about the instruments, land surveying law, professional practice, professional ethics, GIS, photogrammetry and drones, and LiDAR, and communication skills.)

  This question was about the performance of new S-G employees under the prevailing S-G education structure in Georgia. The Georgia BOR defines the education requirements for PLS qualification in S1 to S5+ level courses. This question was about the efficiency of the applicants who are qualified having taken the S1 to S5+ level courses. Moreover, this question seeks to identify the performance of new S-G professionals in handling the surveying instruments, knowledge about the boundary law, professional practice as well as ethics, and knowledge about the advanced surveying tools, such as GIS, LiDAR, photogrammetry, remote sensing, etc.

- Question 28 [4-03] *"[4-03a] The Georgia Board of Registration considers five levels of Surveying-Geomatics courses: S1=Foundations in Surveying; S2=Advanced Surveying; S3=Legal Aspects; S4=Professional Practice; and S5+=Additional Courses (i.e., GIS, LiDAR, Photogrammetry courses). Please, indicate your perception on how these course levels support the requirements of advanced technologies in the S-G field. Please, select all answers that are appropriate."*

  This question was developed to determine if the knowledge covered in the courses prescribed by the Georgia BOR trains the students about the new technologies and field applications. The answers from question 28 indicate the respondent's rating of the performance of the S-G education system.

- Question 29 [4-04] *"Georgia has four S-G educational institutions, i.e., Albany Technical College (ATC), Georgia Southern University (GSU), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia?"*

This question was developed to evaluate the groups of graduates in the S-G field coming from the four available educational institutes, i.e., ATC, GSU, KSU, and UNG, in Georgia. The participants gave their comments on whether the number of graduates is sufficient in the specified university based on their own perception and not based on an accurate number.

- Question 30 [4-05] *"Do you think the S-G educational institutions in Georgia can provide the required knowledge for the 21st century?"*

  This question allowed the respondents to evaluate the capability of S-G educational institutes in Georgia. The evaluations are based on the lab infrastructure and the instructors of these universities. Again, this evaluation is not quantitative, but rather the participant's perception of these issues.

- Question 31 [4-06] *"Do you think the Surveying–Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs?"*

  This question was intended to understand whether the educational institutions are developing graduates fit for the S-G professional need, i.e., students can apply professional knowledge in the appropriate situation.

- Question 32 [4-07] *"Given the following options, please select what you think is the most effective method of class presentation for student learning?"* and Question 33 [4-08] *"Considering face-to-face, online, and hybrid class course presentation methods, which one is the most suitable for S-G courses?"*

These questions evaluated the effectiveness of the presentation methods of classes, which are face-to-face, hybrid, or online systems, in the context of knowledge sharing and assimilation, flexibility, and presentation.

- Questions 34 [4-09] to 36 [4-11] *"Compare and rank the four S-G educational institutions in Georgia according to..."*

  These questions provided three parts, where each part stood for the qualitative ranking of the four educational institutions in terms of S-G course availability, skills among the graduates, and availability of experienced instructors, respectively. These questions provided a comparative idea of the quality of these institutes and, hence, the scope of needed future development or improvement.

All the questions in the section gave direction toward understanding the S-G education status and the S-G professional needs in Georgia. The casual relationships of variables developed from the responses will help the researchers evaluate the existing S-G education structure in the state.

ISSUANCE AND COLLECTION OF SURVEYS

Survey Form Development (Google Forms)

An important characteristic of the designed survey was its anonymity. It was developed in Google Forms with the "Collect email addresses" option disabled. That is, email addresses participants used to connect to the survey were not collected, and this made their identities unknown.

The survey consisted of four major sections with a total of 37 multiple-choice questions. Fourteen (14) of those were two-part questions (parts a and b) that required short written answers in part b. The different types of questions employed in this survey are briefly described below, where an alphanumeric ID code (*in italic*) was assigned to them for ready identification of their types:

- Single-part questions or part a of two-part questions:
  - Multiple choice with n options in a single column (*M-C, n×1*) or
  - Multiple-choice grids with options distributed in the cells of an r×c matrix, where r is the number of rows and c is the number of columns (*M-C G, r×c*) or
  - Multiple-choice with n options in a single column and where more than one answer can be selected (*M-C, n×1+*)
- Part b of two-part questions
  - Short written answers (*W*)

Section 1 was designed to acquire *participant demographics*, such as their level of education, salary range, having professional land-surveyor licensure or not, etc. It contained five questions—three simple Yes/No questions and the remaining two multiple-choice questions with five options each, as described below.

Question [1-01]: *M-C*, *5×1*, select one option out of 5.

Question [1-02]: *M-C*, *2×1*, select one option out of 2.

Question [1-03]: *M-C*, *2×1*, select one option out of 2.

Question [1-04]: *M-C*, *2×1*, select one option out of 2.

Question [1-05]: *M-C*, *5×1*, select one option out of 5.

Section 2 contained 10 questions on *S-G knowledge and skills*. Each of these questions was formatted as a multiple-choice grid. That is, for each of them, participants were presented a matrix with a certain number of rows and columns and were asked to select optional answers corresponding to each cell. Five of those questions (i.e., [2-01], [2-02], [2-07], [2-09], and [2-10]) contained an equal number of rows and columns, and participants were instructed to select one optional answer (cell) per row and per column. Another four questions (i.e., [2-03], [2-04], [2-05], and [2-06]) contained more rows than columns, and participants were instructed to select one answer (cell) per column. Therefore, in this group, not all rows would contain a selected answer. Finally, one last question in this section (i.e., [2-08]) contained 4 rows and 4 columns, and participants were asked to select one answer per row. That is, in question [2-08], participants were allowed to select more than one answer (cell) per column. All questions for section 2 are described as follows:

Question [2-01]: *M-C G, 5×5*, select one option per row and one per column.

Question [2-02]: *M-C G, 5×5*, select one option per row and one per column.

Question [2-03]: *M-C G, 9×5*, select one option per column.

Question [2-04]: *M-C G, 9×5*, select one option per column.

Question [2-05]: *M-C G, 19×5*, select one option per column.

Question [2-06]: *M-C G, 19×5*, select one option per column.

Question [2-07]: *M-C G, 4×4*, select one option per row and one per column.

Question [2-08]: *M-C G, 4×4*, select one option per row; may select ≥1 per column

Question [2-09]: *M-C G, 3×3*, select one option per row and one per column.

Question [2-10]: *M-C G, 3×3*, select one option per row and one per column.

Section 3 contained 10 questions on *S-G job positions*. Three of the 10 questions had two parts, a and b (i.e., [3-01], [3-06], and [3-07]). Parts a were multiple-choice questions and parts b contained an open-ended question related to their respective parts a. Question [3-01a] was a three-option multiple-choice question, whereas [3-07a] was a five-option multiple-choice question. Additionally, question [3-06a] presented three potential answers, and participants were asked to select all answers that were appropriate. This section also contained six other multiple-choice questions (i.e., [3-02], [3-03], [3-04], [3-08], [3-09], and [3-10]) with three options each. Finally, this section had a 4×4 grid question [3-05] where participants could select one answer (cell) per row and per column.

Question [3-01a]: *M-C*, *3×1*, select one option out of 3.

[3-01b]: *W*, short written answer.

Question [3-02]: *M-C*, *3×1*, select one option out of 3.

Question [3-03]: *M-C*, *3×1*, select one option out of 3.

Question [3-04]: *M-C*, *3×1*, select one option out of 3.

Question [3-05]: *M-C* G, *4×4*, select one option per row and one per column.

Question [3-06a]: *M-C*, *3×1+*, may select all answers that are appropriate.

[3-06b]: *W*, short written answer.

Question [3-07a]: *M-C*, *5×1*, select one option out of 5.

[3-07b]: *W*, short written answer.

Question [3-08]: *M-C*, *3×1*, select one option out of 3.

Question [3-09]: *M-C*, *3×1*, select one option out of 3.

Question [3-10]: *M-C*, *3×1*, select one option out of 3.

Section 4 presented 11 questions on *S-G education/subject coverage*, and 1 additional two-part question [4-12a and b] on the quality of the survey itself. Most of these questions were two-part questions, except question [4-07]. Questions [4-01a], [4-02a], [4-04a], [4-05a], [4-06a], [4-07a], [4-09a], [4-10a], and [4-11a] were all formatted as multiple-choice grid questions, but with different characteristics. Questions [4-01a], [4-09a], [4-10a], and [4-11a] each had an equal number of rows and columns, where participants select one answer (cell) per row and per column. However, in questions [4-02a], [4-04a], [4-05a], [4-06a], and [4-07] participants selected one answer (cell) per row and could select more than one answer (cell) per column. Question [4-03a] was a three-option multiple-choice question, where participants could select all options that were appropriate. Questions [4-08a] and [4-12a] were three- and five-option multiple-choice questions, respectively. All these questions are indicated below with their ID codes in italic:

Question [4-01a]: *M-C G*, *3×3*, select one option per row and one per column.

[4-01b]: *W*, short written answer.

Question [4-02a]: *M-C G*, *8×3*, select one option per row; may select ≥1 per column.

[4-02b]: *W*, short written answer.

Question [4-03a]: *M-C*, *4×1+*, select all answers that are appropriate.

[4-03b]: *W*, short written answer.

Question [4-04a]: *M-C G*, *4×4*, select one option per row; may select ≥1 per column.

[4-04b]: *W*, short written answer.

Question [4-05a]: *M-C G*, *4×5*, select one option per row; may select ≥1 per column.

[4-05b]: *W*, short written answer.

Question [4-06a]: *M-C G*, *4×4*, select one option per row; may select ≥1 per column.

[4-06b]: *W*, short written answer.

Question [4-07]: *M-C G*, *4×4*, select one option per row; may select ≥1 per column.

Question [4-08a]: *M-C*, *3×1*, select one option out of 3.

[4-08b]: *W*, short written answer.

Question [4-09a]: *M-C G*, *4×4*, select one option per row and one per column.

[4-09b]: *W*, short written answer.

Question [4-10a]: *M-C G*, *4×4*, select one option per row and one per column.

[4-10b]: *W*, short written answer.

Question [4-11a]: *M-C G*, *4×4*, select one option per row and one per column.

[4-11b]: *W*, short written answer.

Question [4-12a]: *M-C*, *5×1*, select one option out of 5.

[4-12b]: *W*, short written answer.

When the answers to all these questions were collected in an associated Microsoft Excel spreadsheet, they spanned along 155 Excel columns. This includes a first column containing timestamps, indicating the times at which respondents submitted their completed surveys. The data on each of these Excel columns were processed and a related 2D graph was generated. (Note: The Microsoft Word version of the survey is included in appendix J of this report.)

Issuance

Email

For the 2,350 contacts for which an email address could be located, emails were sent out that included instructions and a link to the Google Forms page where the survey was located.

U.S. Mail

For the 637 contacts that did not have an email address, mailouts were sent via the U.S. Postal Service to provide the necessary information to participate in the survey. Their addresses were found from the SAMSOG member list and the GBORPELS's registered PLS list. Initially, the plan was to mail a paper copy of the actual survey to each contact, but due to issues with that process, a one-page letter containing instructions, a URL link, and a QR code to access the Google Forms survey was sent in lieu of the complete survey.

Sending out only one page decreased the amount of time to prepare all the envelopes to be sent out. The first step of this process involved using the mail merge tool in Microsoft Word to format and print the address labels and the return address labels. The next step was to apply the labels to the envelopes and then insert the information letter. This process was completed quickly by a team of the graduate and undergraduate researchers.

Including the QR code made it possible for the survey participants to complete the survey on their mobile device, which was probably more suitable for some of the participants. As mentioned previously, the URL for the survey was also provided so the participants could access the survey on a computer, as well.

GSU Institutional Research Board Approvals

Since the project research survey was considered a “human subjects” activity, approval from GSU’s Institutional Research Board (IRB) was required under a designated exemption category. Thus, the time-intensive task of obtaining this approval was completed; copies of the IRB approval and the required consent document are contained in appendix I of this report.

CHAPTER 6.
TASK 5: SURVEY DATA ANALYSIS

RAW DATA

The raw data for the complete survey were extracted from the Excel file and copied into a Word document and are available in their entirety in appendix K.

DATA ANALYSIS: RESPONDENT CHARACTERIZATION

For submission of the respondents' surveys, the timestamp (#TS) accumulates the number of actual survey submissions. In this survey, 82 out of 83 (99 percent) respondents successfully submitted timestamps for the survey (see figure 6).

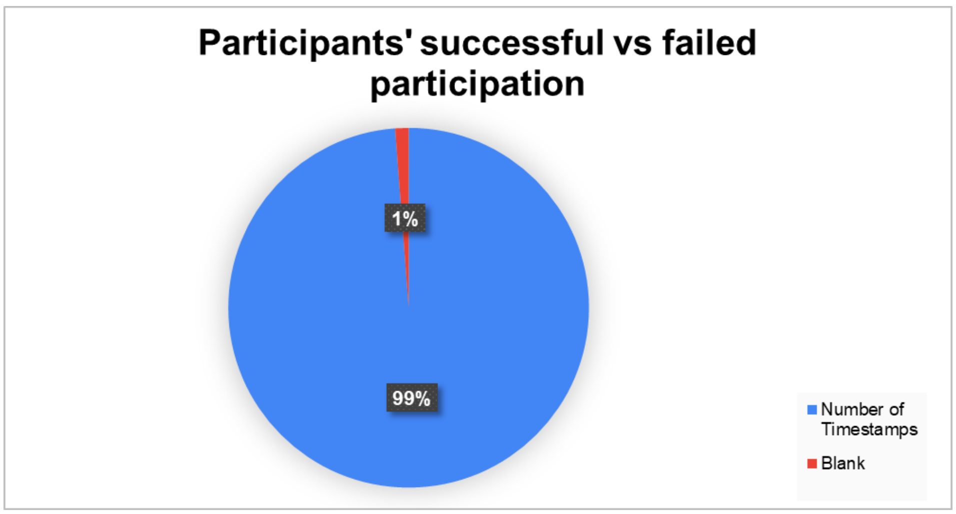


Figure 6. Pie graph. Timestamps.

For question [1-01], the data show that the level of education of most respondents was a bachelor's degree, with 42 out of 81 (51.9 percent) having a bachelor's degree. There were 12 respondents (14.8 percent) with a master's degree and only 1 respondent (1.2 percent), with a doctoral degree. All others either went with the non-traditional pathway, 17 respondents

(21 percent), or another level of education, 9 respondents (11.1 percent). See figure 7 for a breakdown of these results.

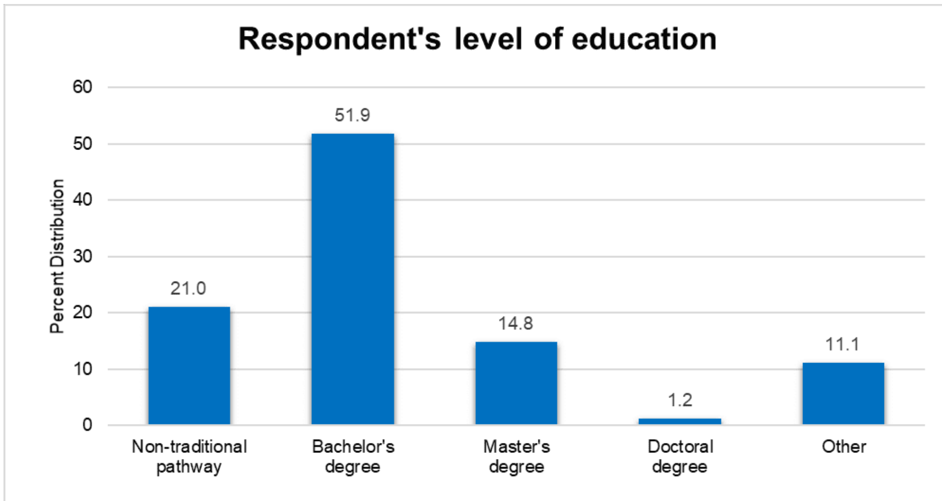


Figure 7. Bar graph. Level of education [1-01].

For question [1-02], the data show that most respondents did not specialize in one S-G area; 48 of 81 (59.3 percent) indicated No as their answer (see figure 8). Thus, the inference is that most respondents cover multiple areas in S-G.

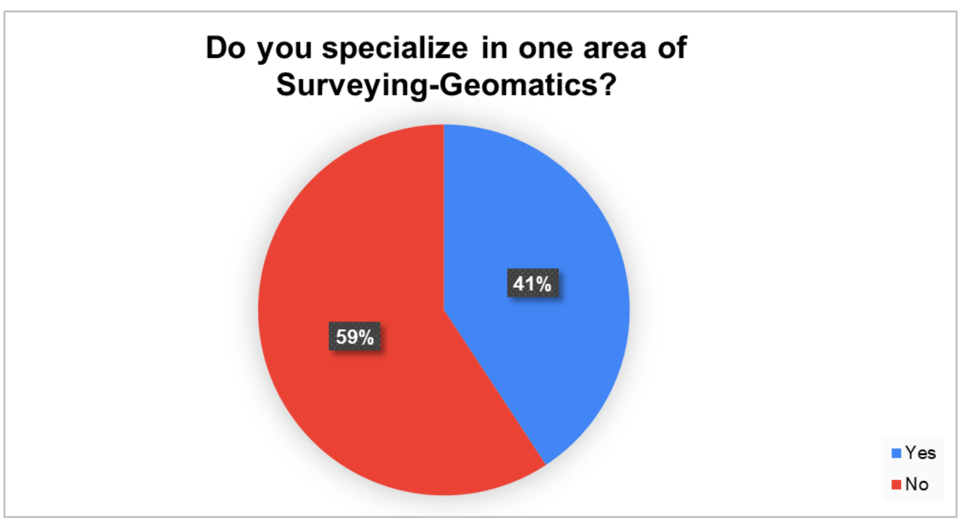


Figure 8. Pie graph. S-G specialization [1-02].

For question [1-03], the data show that most respondents were not employed by a public entity; 65 of 81 (80.2 percent) indicated No as their response (see figure 9). Therefore, the apparent majority of S-G personnel work in the private sector.

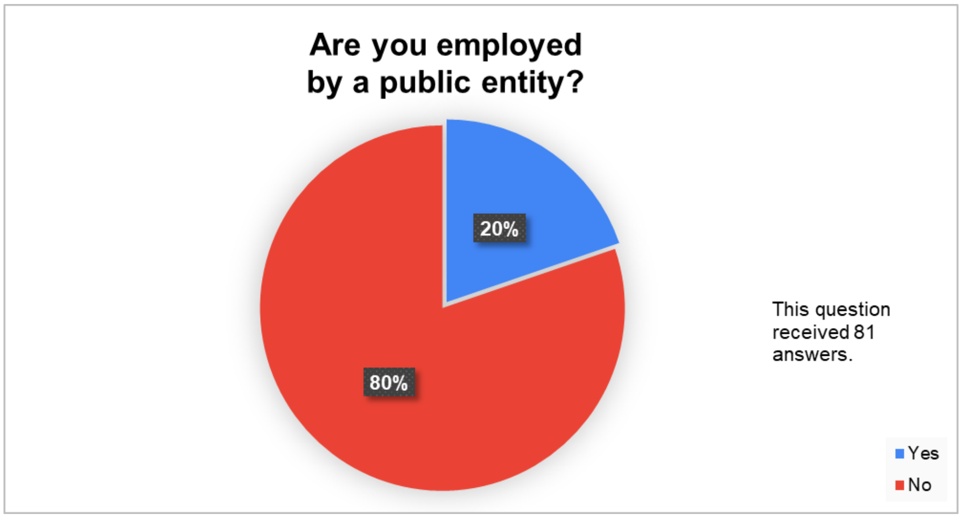


Figure 9. Pie graph. Employment with a public entity [1-03].

For question [1-04], the data show that most respondents were licensed professional land surveyors in the State of Georgia; 61 of 80 (76.3 percent) indicated Yes as their answer (see figure 10).

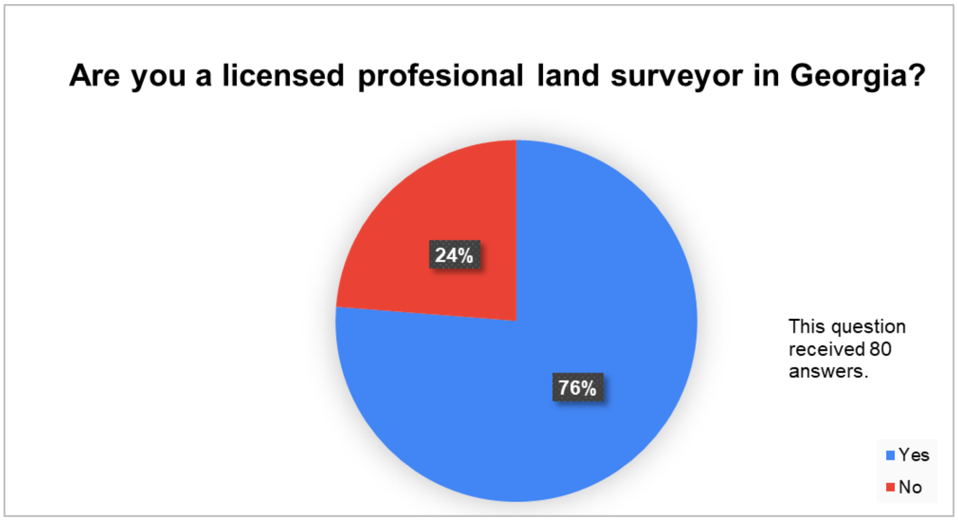


Figure 10. Pie graph. Georgia PLS license [1-04].

For question [1-05], the data show that most respondents had a salary (in U.S. dollars) of $100K and over; 37 out of 82 (45.1 percent) indicated that they had this salary (see figure 11). The lowest salary range shown was a range of $20K to $39K, with 5 of 82 (6.1 percent) having this salary. Eight respondents (9.8 percent) had a salary between $40K and $59K, 19 (23.2 percent) had a salary between $60K and $79K, and 13 (15.9 percent) had a salary of $80K to $99K. See figure 11 for a distribution of salaries.

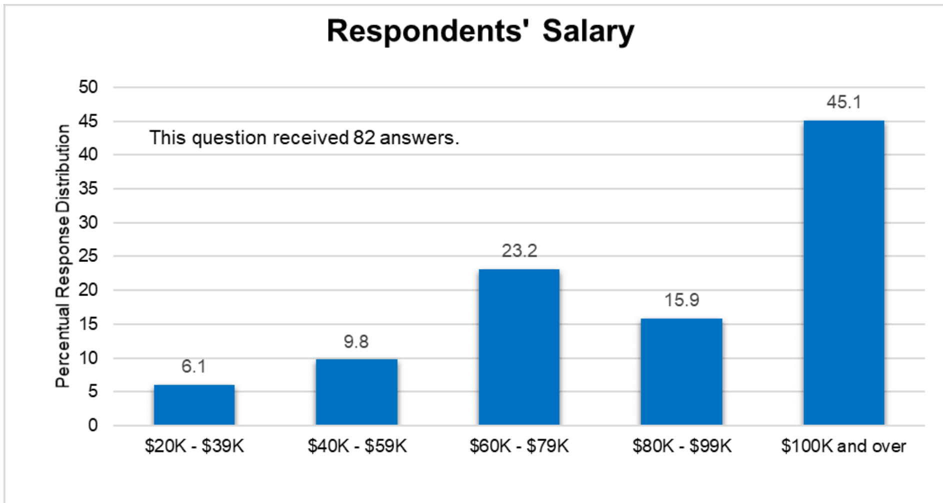
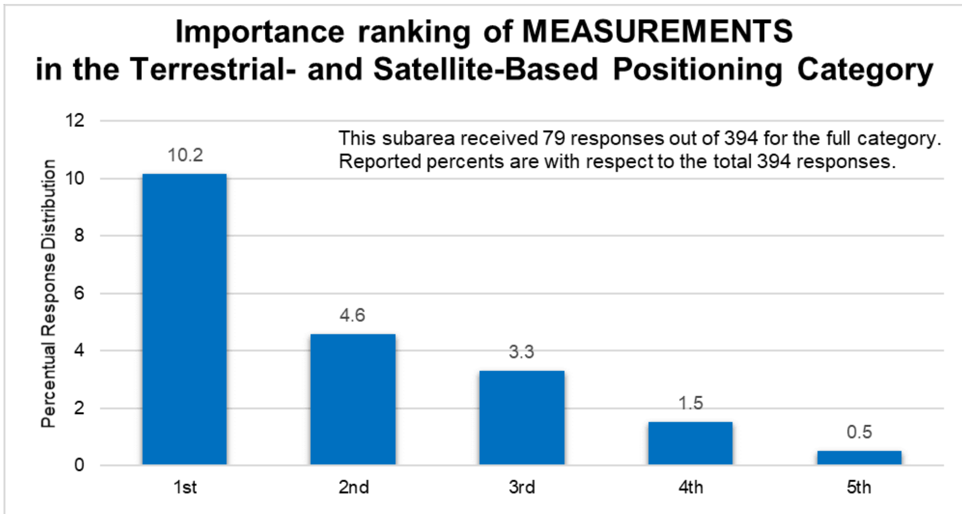


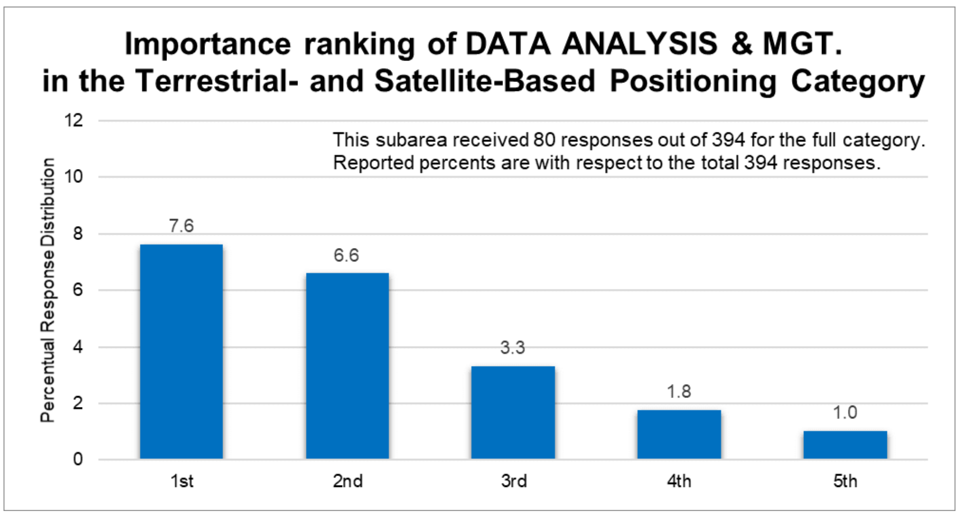
Figure 11. Bar graph. S-G salaries [1-05].

DATA ANALYSIS: S-G KNOWLEDGE/SKILL NEEDS

In question [2-01] (see figure 12), the measurements category was ranked as having the first (or greatest) importance to the daily operation within S-G for the terrestrial and satellite-based positioning category with a score of 40 out of 79 (10.2 percent) of 479 total responses. Data analysis and management was ranked as having the first importance with 30 of 80 (7.6 percent) of total responses. Adjustments was ranked as having the fourth importance with 25 of 78 (6.3 percent) of total responses. Coordinate geometry was ranked as having the fourth importance with 32 of 78 (8.1 percent) of total responses. Information extraction was ranked as having the fifth importance with 43 of 79 (10.9 percent) of total responses. (Note: Percentages are weighted to the total responses for importance to the daily operation.)

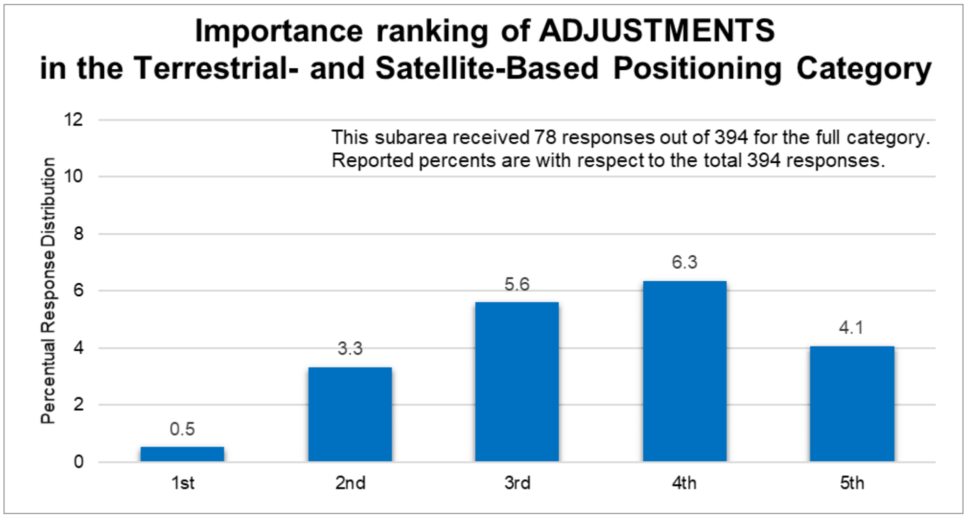


A. Importance ranking: Measurements [2-01].

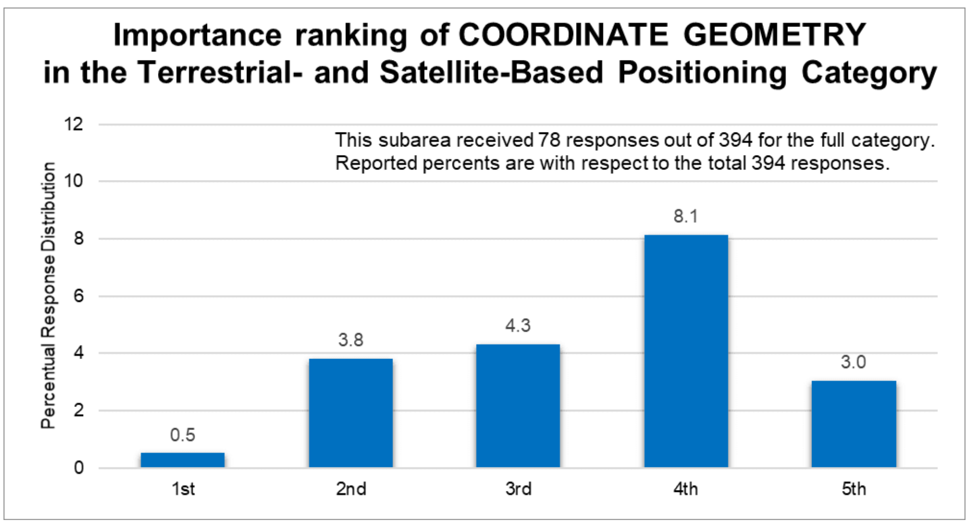


B. Importance ranking: Data analysis and management [2-01].

Figure 12. Bar graphs. Importance rankings in the terrestrial-and satellite-based positioning category: (A) measurements, (B) data analysis and management, (C) adjustments, (D) coordinate geometry, and (E) information extraction [2-01].

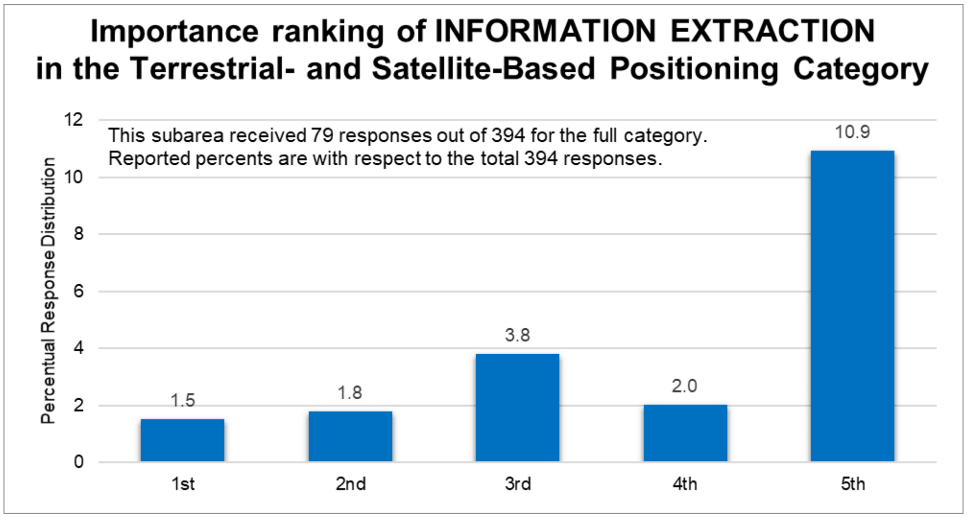


C. Importance ranking: Adjustments [2-01].



D. Importance ranking: Coordinate geometry [2-01].

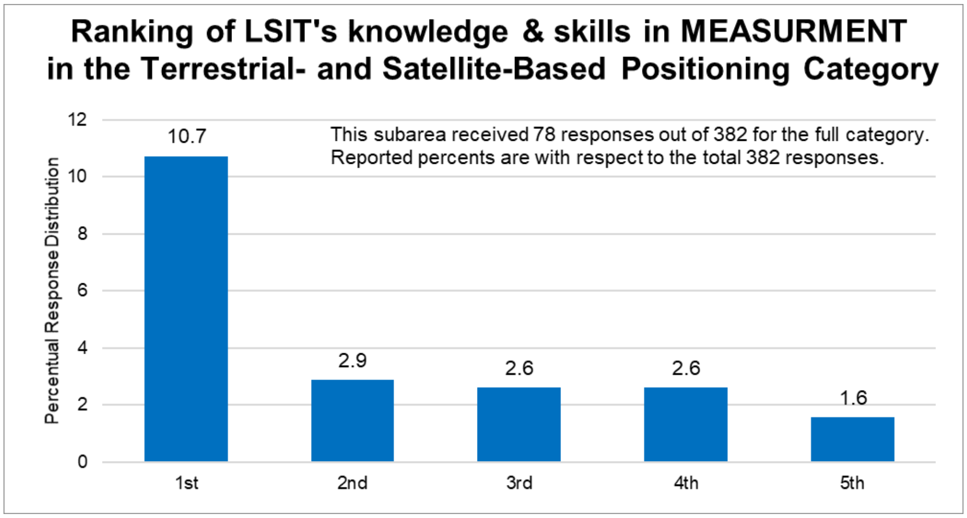
Figure 12. (Continued).



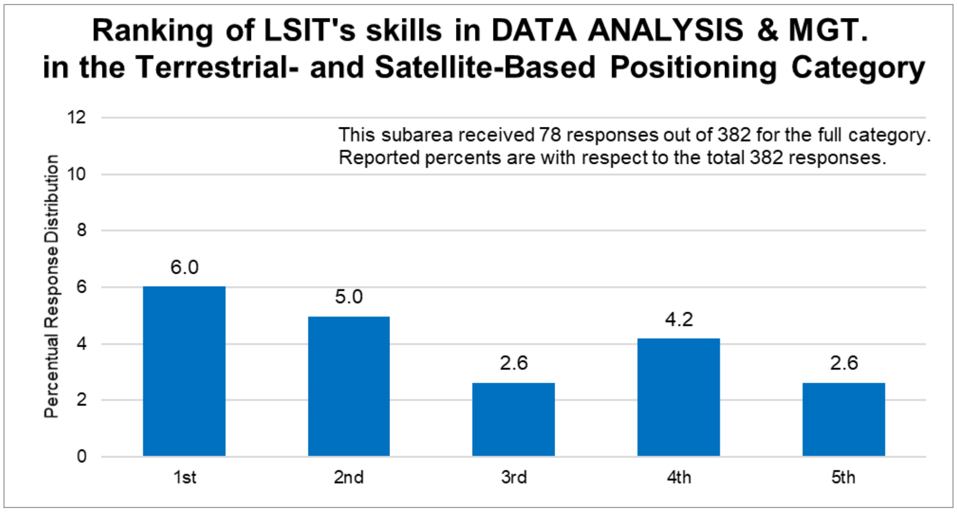
E. Importance ranking: Information extraction [2-01].

Figure 12. (Continued).

In question [2-02], measurement was ranked as being the first strongest knowledge and skill for a newly licensed land surveyor in training for the terrestrial and satellite-based positioning category with a score of 41 of 78 (10.7 percent) of the 382 total responses (see figure 13). Data analysis and management was ranked as being the first strongest knowledge and skill for a newly licensed LSIT with 23 of 78 (6.0 percent) of the total responses. Adjustments was ranked as being the third strongest knowledge and skill for a newly licensed LSIT with 26 of 76 (6.8 percent) of the total responses. Coordinate geometry was ranked as being the fourth strongest knowledge and skill for a newly licensed LSIT with 21 of 74 (5.5 percent) of the total responses. Information extraction was ranked as being the fifth strongest knowledge and skill for a newly licensed LSIT with 30 of 76 (7.9 percent) of the total responses. (Note: Percentages are weighted to the total responses for strongest knowledge and skill for a newly licensed LSIT.)

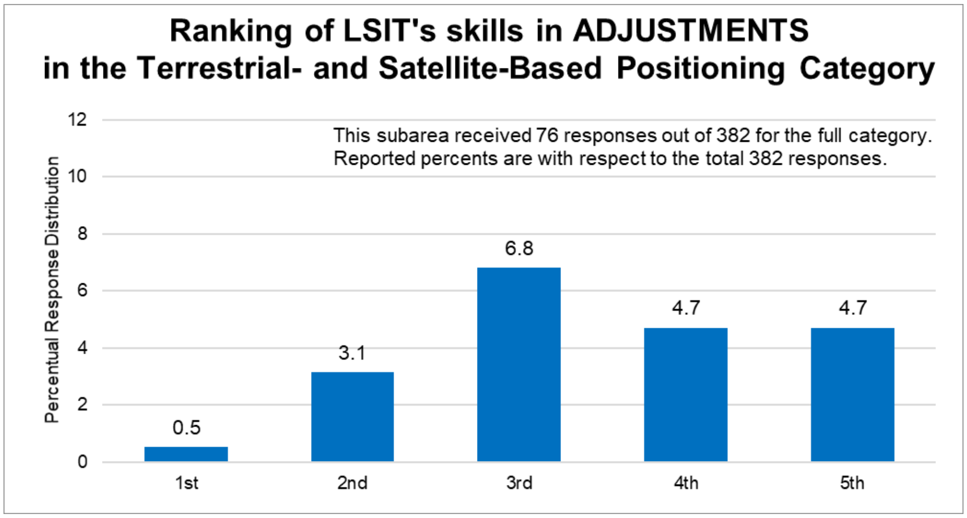


A. Knowledge and skills ranking: Measurement [2-02].

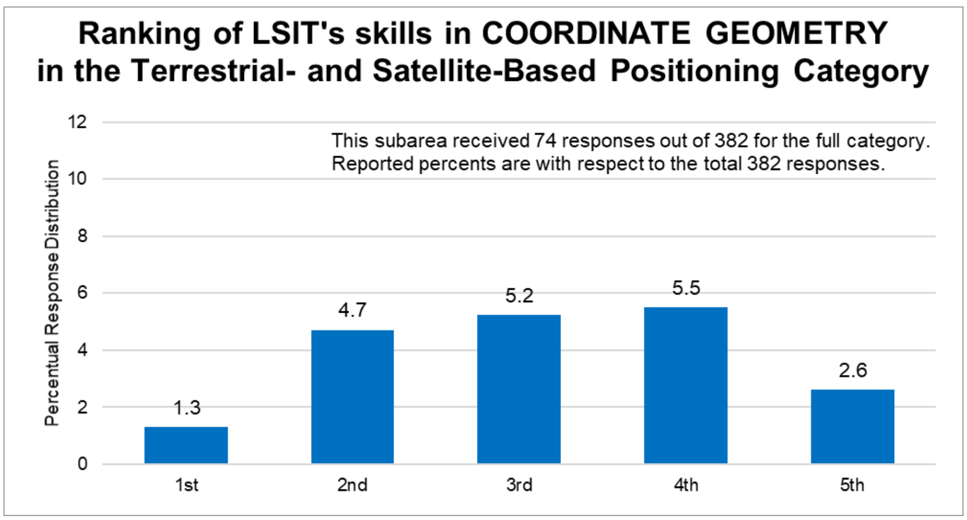


B. Knowledge and skills ranking: Data analysis and management [2-02].

Figure 13. Bar graphs. Knowledge and skills rankings in the terrestrial- and satellite-based positioning category: (A) measurement, (B) data analysis and management, (C) adjustments, (D) coordinate geometry, and (E) information extraction [2-02].

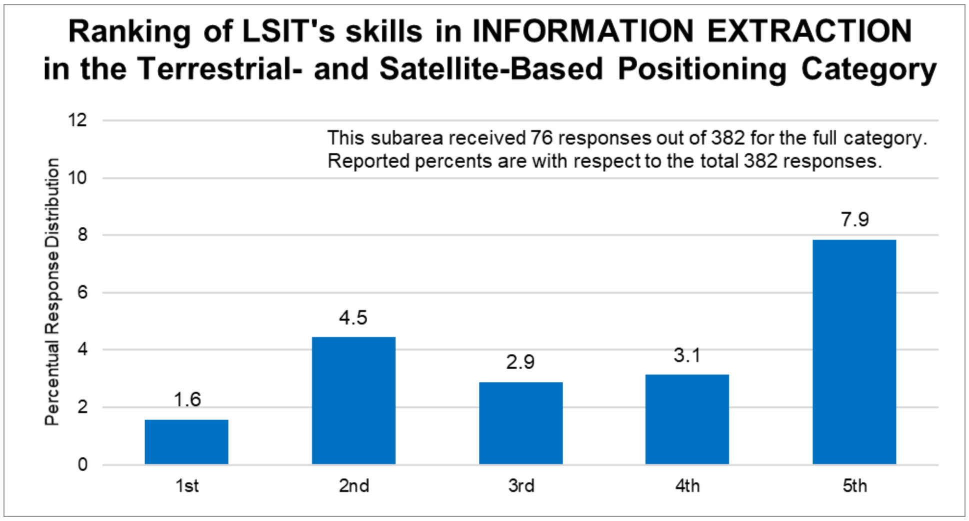


C. Knowledge and skills ranking: Adjustments [2-02].



D. Knowledge and skills ranking: Coordinate geometry [2-02].

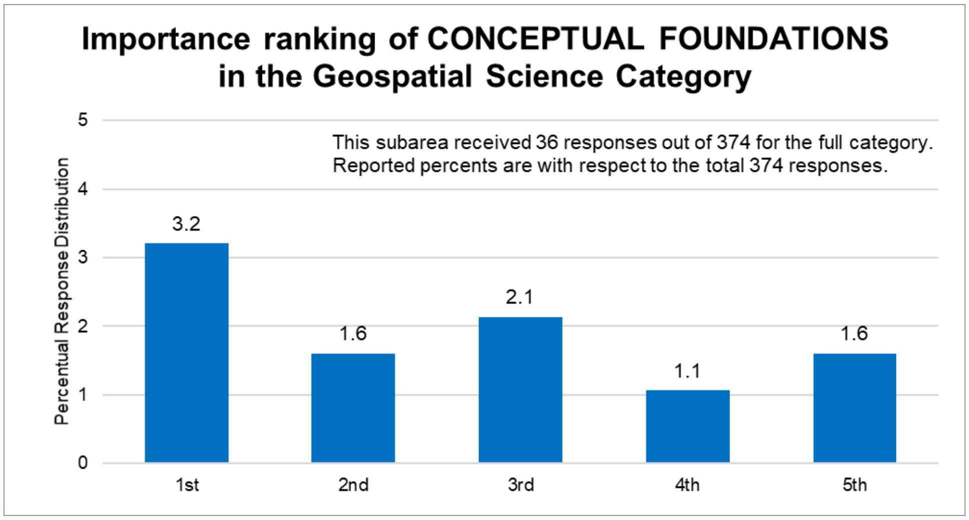
Figure 13. (Continued).



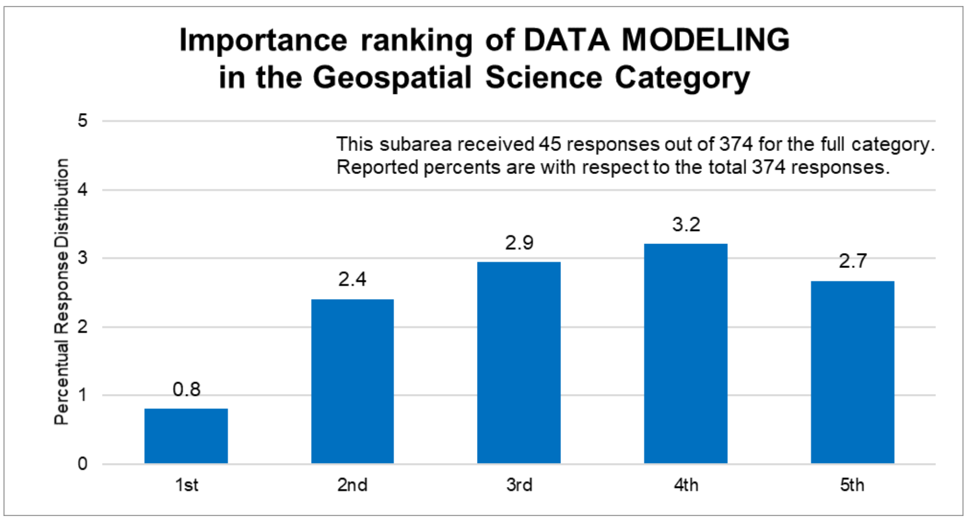
E. Knowledge and skills ranking: Information extraction [2-02].

Figure 13. (Continued).

In question [2-03], conceptual foundations was ranked as having the first importance to the daily operation within surveying–geomatics for the geospatial science category with 12 out of 36 (3.2 percent) of the 374 total responses (see figure 14). Data modeling was ranked as having the fourth importance with 12 of 45 (3.2 percent) of the total responses. Design aspects was ranked as having the fifth importance with 10 of 32 (2.7 percent) of the total responses. Geospatial data was ranked as having the first importance with 17 of 55 (4.5 percent) of the total responses. Data manipulation was ranked as having the fourth importance with 13 of 49 (3.5 percent) of the total responses. Analytical methods had a tie for the ranks of second and fourth importance with 13 of 49 (3.5 percent) of the total responses for both. Cartography and visualizations was ranked as having the fifth importance with 8 of 30 (2.1 percent) of the total responses. Legal and ethical aspects of GIS was ranked as having the third importance with 9 of 28 (2.4 percent) of the total responses. Management and organizational aspects was ranked as having the first importance with 13 of 50 (3.5 percent) of the total responses. (Note: Percentages are weighted to the total responses for importance ranking in geospatial science.)

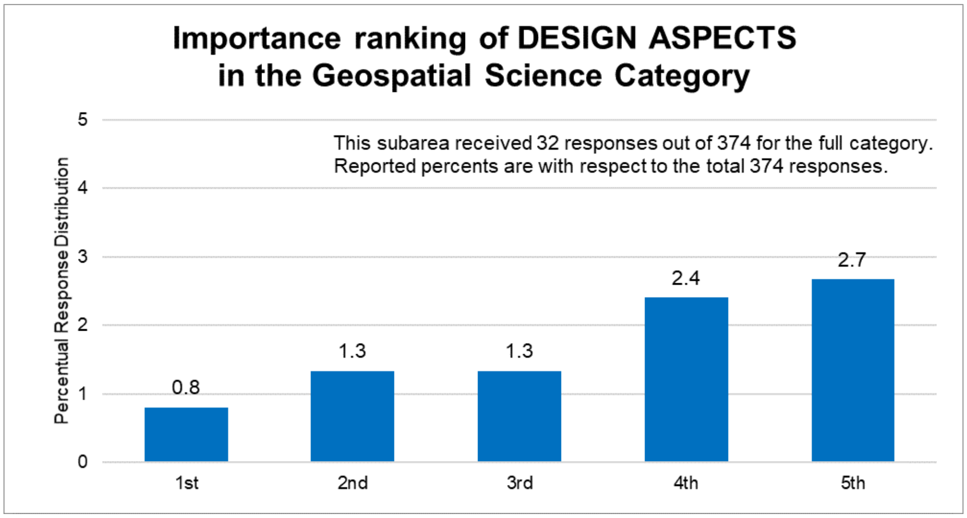


A. Importance ranking: Conceptual foundations [2-03].

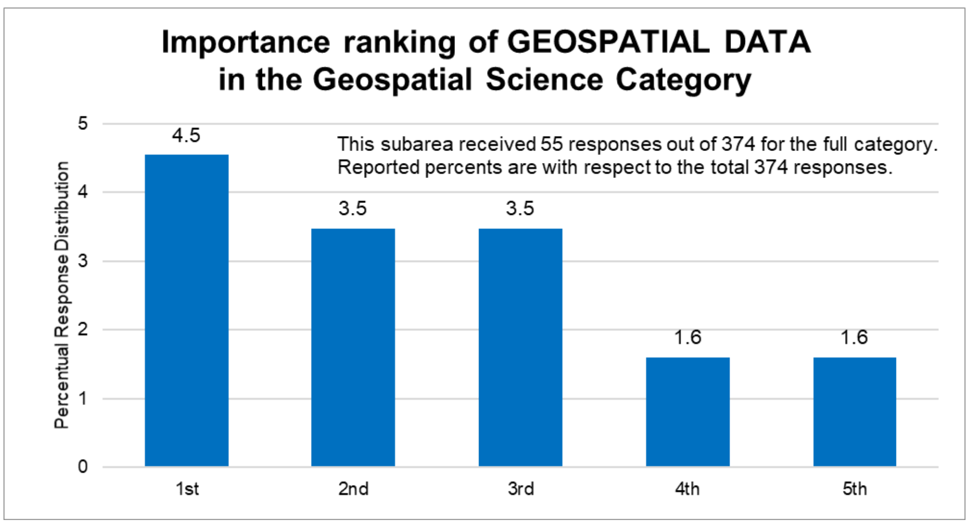


B. Importance ranking: Data modeling [2-03].

Figure 14. Bar graphs. Importance ranking in the geospatial science category: (A) conceptual foundations, (B) data modeling, (C) design aspects, (D) geospatial data, (E) data manipulation, (F) analytical methods, (G) cartography and visualizations, (H) legal and ethical aspects, and (I) management and organizational aspects [2-03].

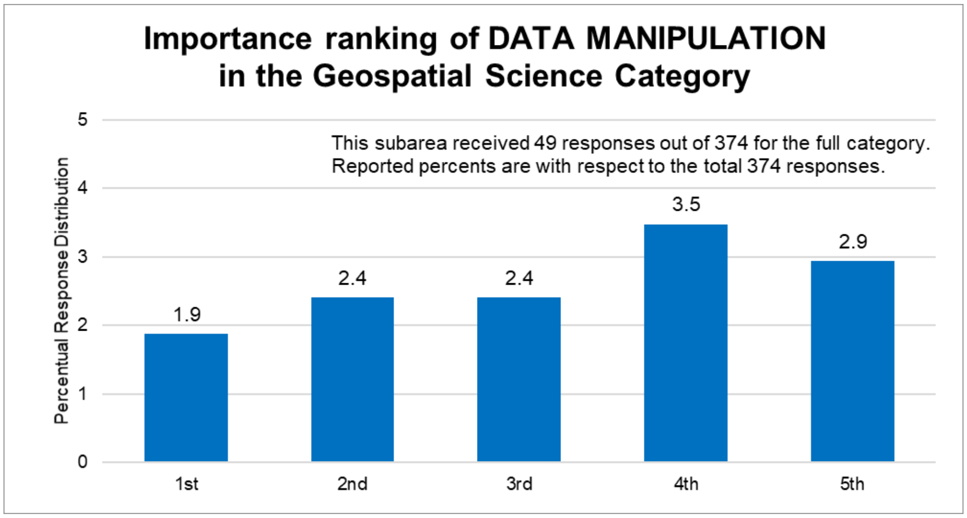


C. Importance ranking: Design aspects [2-03].

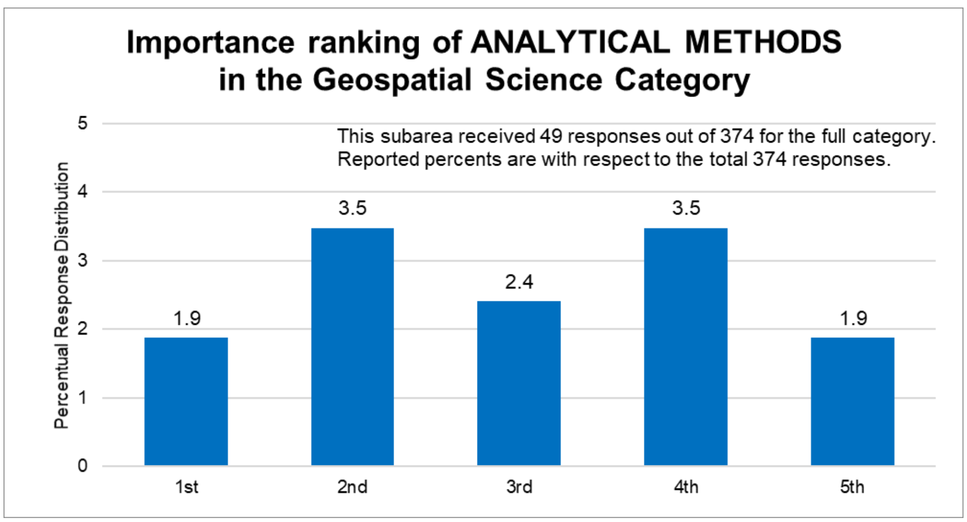


D. Importance ranking: Geospatial data [2-03].

Figure 14. (Continued).

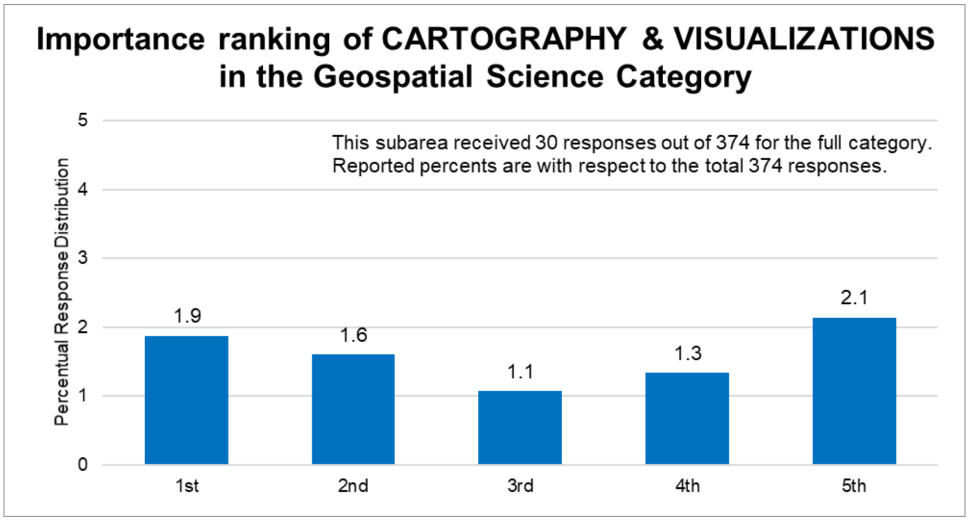


E. Importance ranking: Data manipulation [2-03].

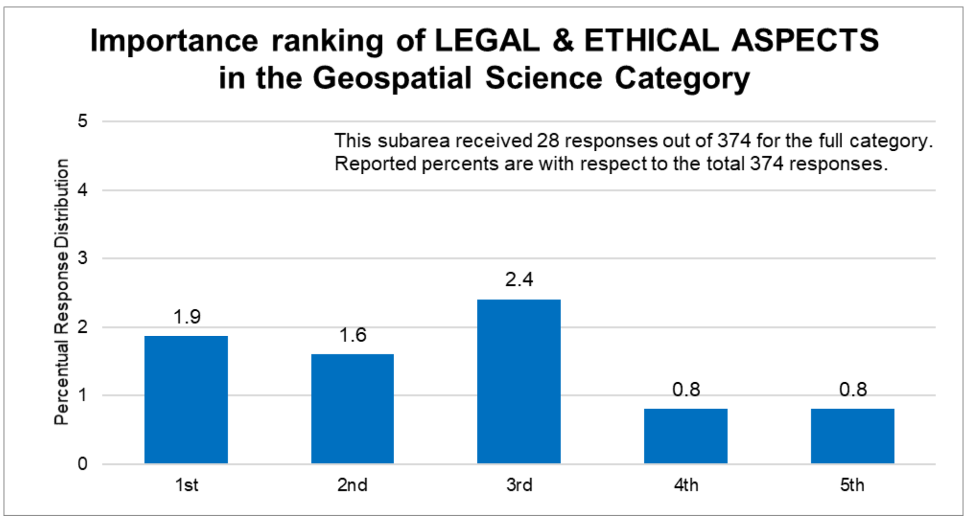


F. Importance ranking: Analytical methods [2-03].

Figure 14. (Continued).

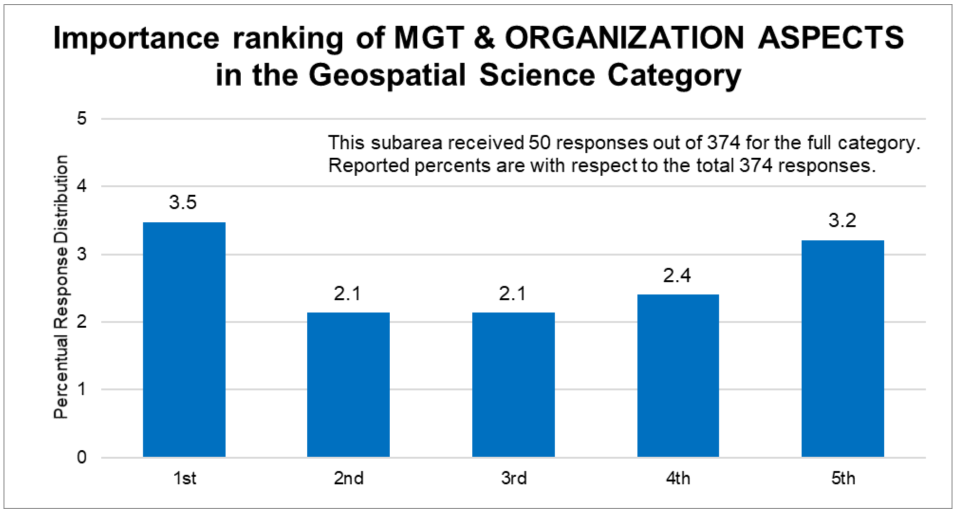


G. Importance ranking: Cartography and visualizations [2-03].



H. Importance ranking: Legal and ethical aspects [2-03].

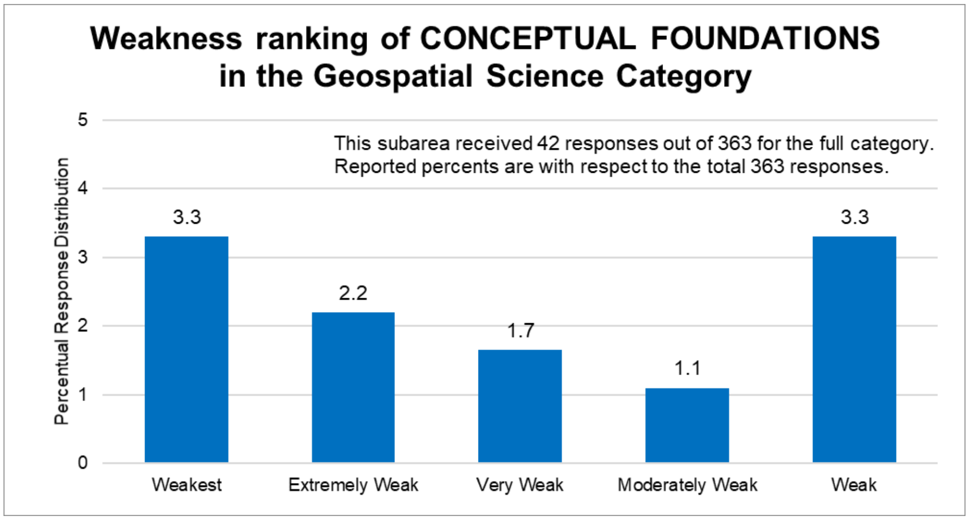
Figure 14. (Continued).



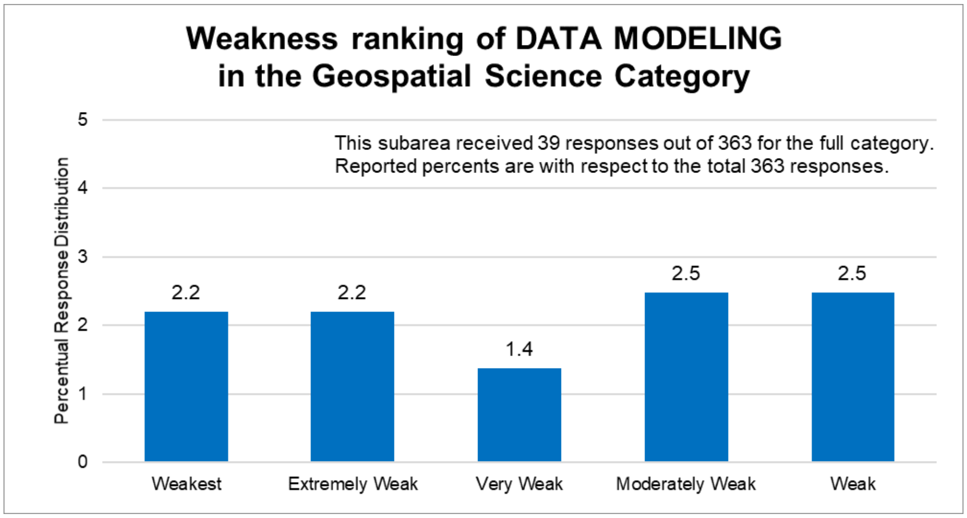
I. Importance ranking: Management and organizational aspects [2-03].

Figure 14. (Continued).

In question [2-04] conceptual foundations had a tie for the ranks of weakest and weak for the knowledge and skill for a newly licensed land surveyor in training for the geospatial science category with 12 of 42 (3.3 percent) of 363 total responses for both (see figure 15). Data modeling had a tie for the ranks of weak and moderately weak with 9 of 39 (2.5 percent) of the total responses for both. Design aspects was ranked as moderately weak with 16 of 42 (4.4 percent) of the total responses. Geospatial data was ranked as moderately weak with 8 of 23 (2.2 percent) of the total responses. Data manipulation was ranked as very weak with 15 of 45 (4.1 percent) of the total responses. Analytical methods was ranked as very weak with 12 of 52 (3.3 percent) of the total responses. Cartography and visualizations was ranked as moderately weak with 8 of 30 (2.2 percent) of the total responses. Legal and ethical aspects of GIS had a tie for the ranks of weak and weakest with 11 of 38 (3.0 percent) of the total responses for both. Management and organizational aspects was ranked as weakest with 16 of 52 (4.4 percent) of the total responses. (Note: Percentages are weighted to the total responses for weakness ranking for a newly licensed LSIT in geospatial science.)

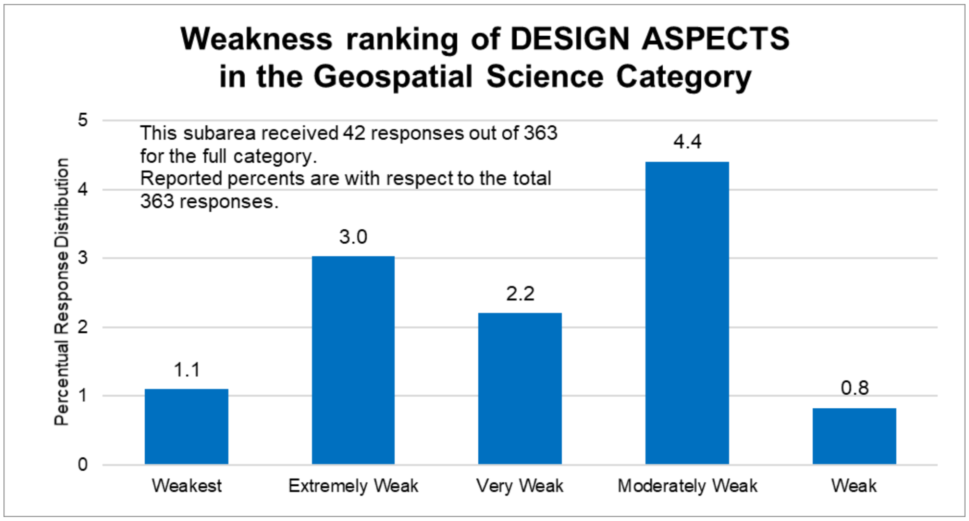


A. Weakness ranking: Conceptual foundations [2-04].

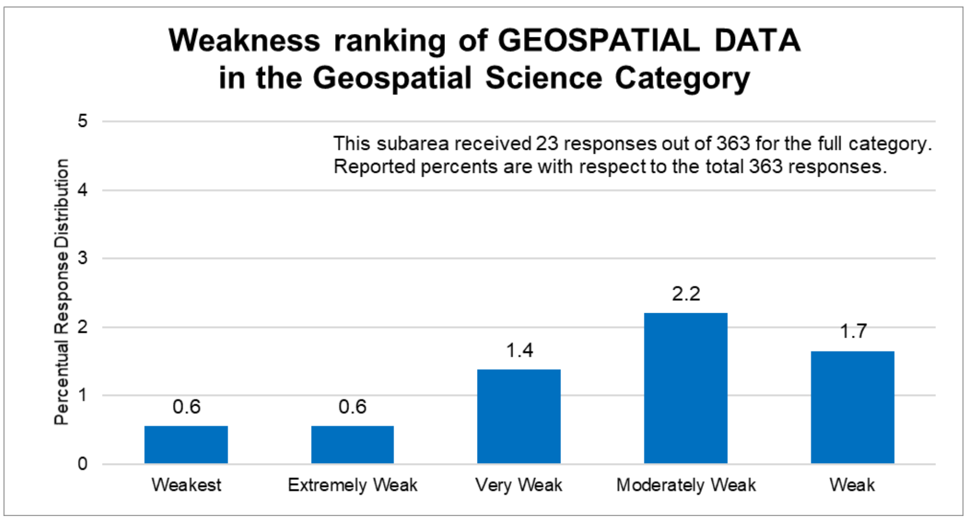


B. Weakness ranking: Data modeling [2-04].

Figure 15. Bar graphs. Weakness rankings in the geospatial science category: (A) conceptual foundations, (B) data modeling, (C) design aspects, (D) geospatial data, (E) data manipulation, (F) analytical methods, (G) cartography and visualizations, (H) legal and ethical aspects, and (I) management and organizational aspects [2-04].

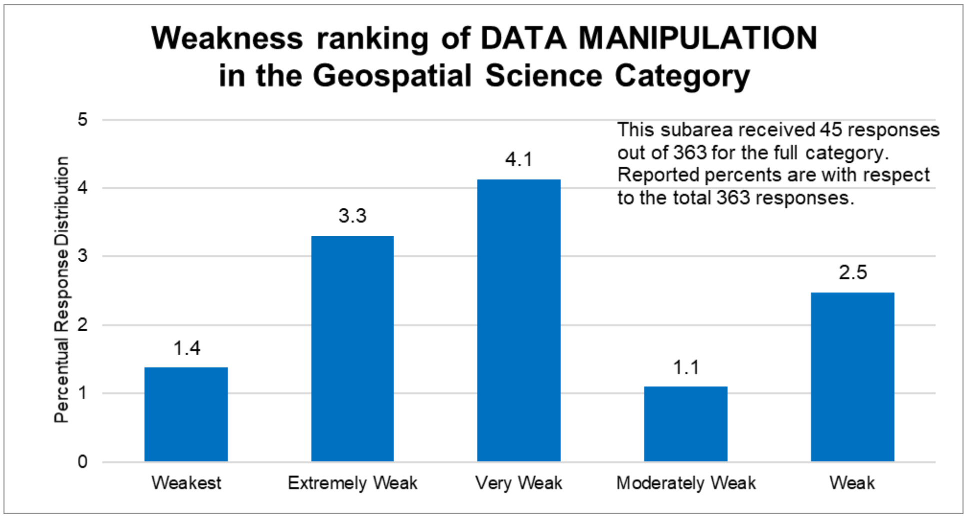


C. Weakness ranking: Design aspects [2-04].

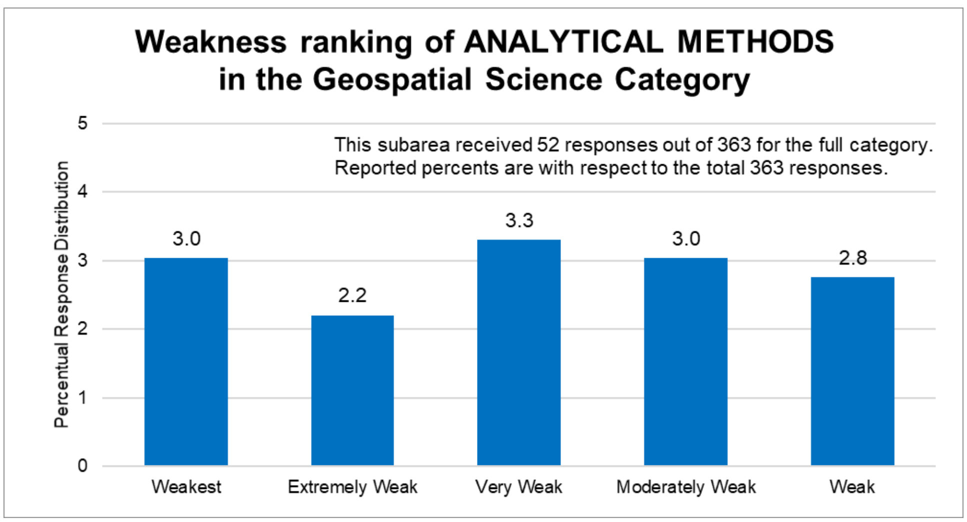


D. Weakness ranking: Geospatial data [2-04].

Figure 15. (Continued).

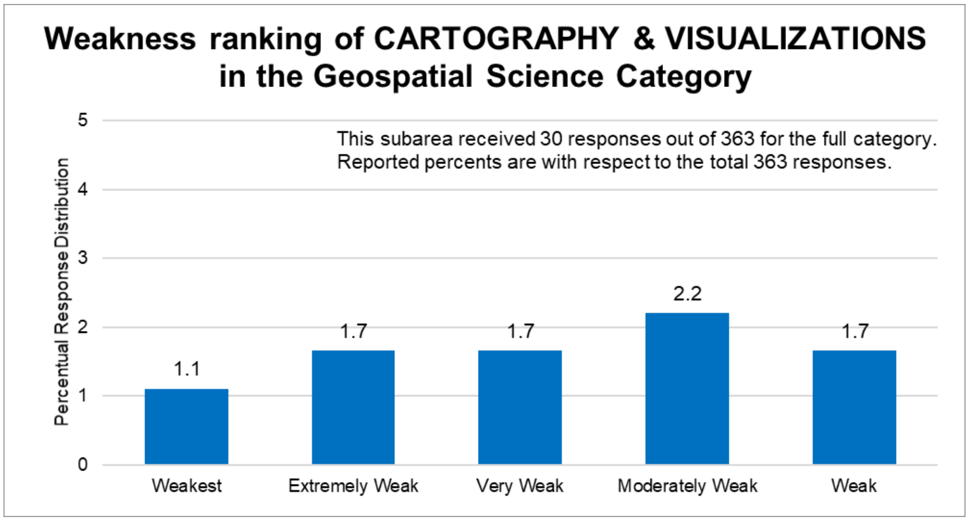


E. Weakness ranking: Data manipulation [2-04].

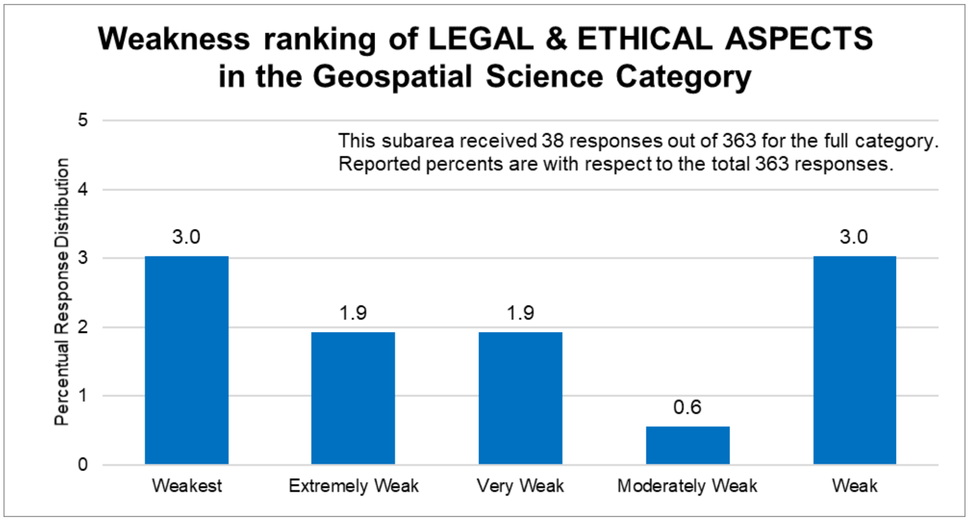


F. Weakness ranking: Analytical methods [2-04].

Figure 15. (Continued).

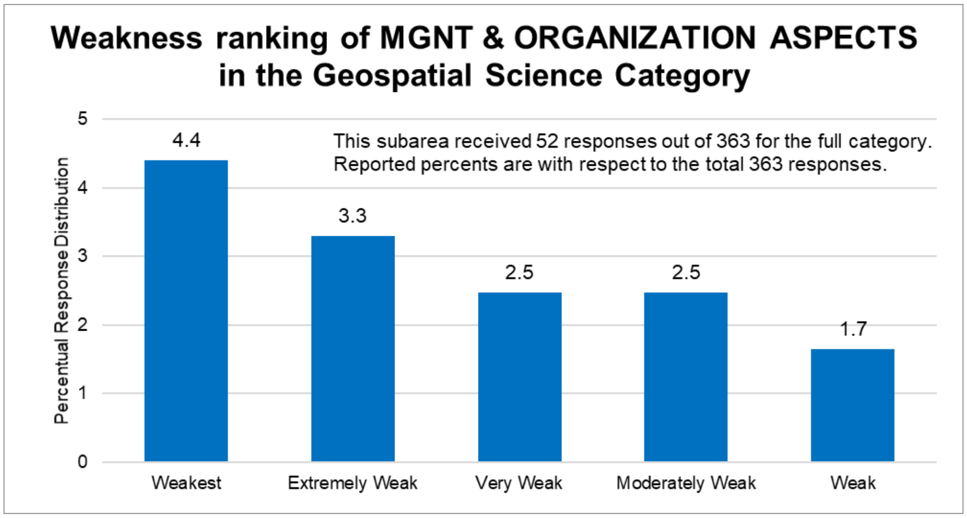


G. Weakness ranking: Cartography and visualizations [2-04].



H. Weakness ranking: Legal and ethical aspects [2-04].

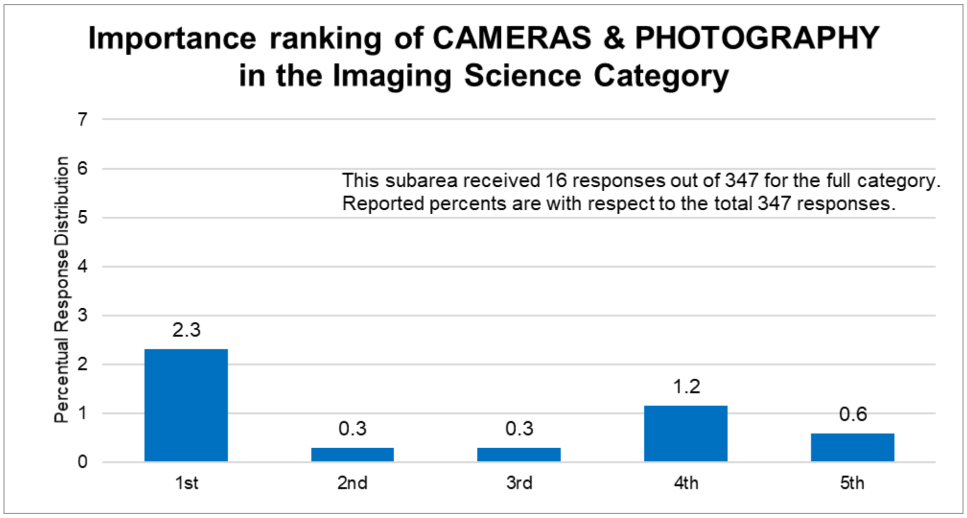
Figure 15. (Continued).



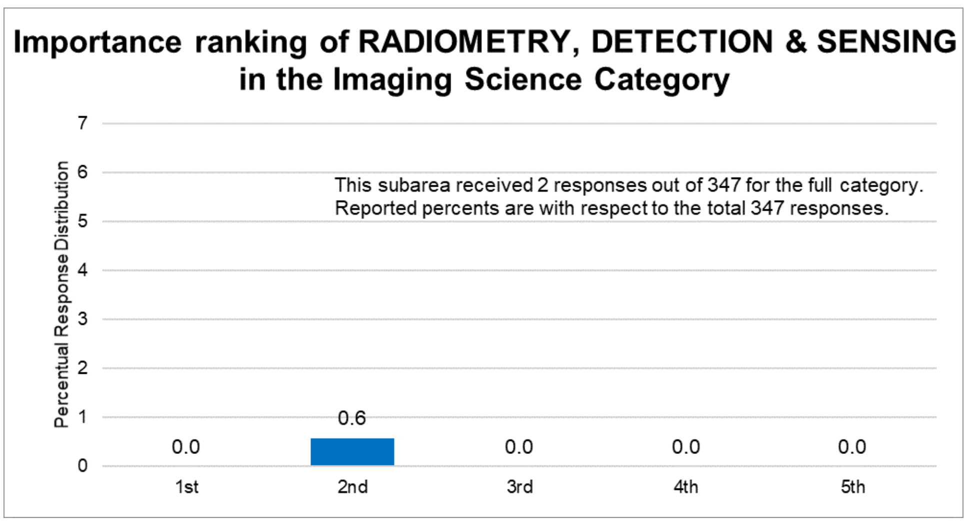
I. Weakness ranking: Management and organizational aspects [2-04].

Figure 15. (Continued).

In question [2-05], cameras and photography was ranked as having the first importance for the daily operation within surveying geomatics for the imaging science category with 8 of 16 (2.3 percent) of 374 total responses (see figure 16). Radiometry, detection, and sensing was ranked as having the second importance with 2 of 2 (0.6 percent) of the total responses. Frame geometry was ranked as having the third importance with 1 of 1 (0.3 percent) of the total responses. Imaging measurements was ranked as having the third importance with 6 of 22 (1.7 percent) of the total responses. Stereoscopy and parallax was ranked as having the third importance with 1 of 1 (0.3 percent) of the total responses. Mathematical modeling and analytical photogrammetry was ranked as having the first importance with 5 of 16 (1.4 percent) of the total responses. Computer vision was ranked as having the fourth importance with 6 of 15 (1.7 percent) of the total responses. Estimation, adjustment, statistics, and error propagation had a tie for the ranks of first, second, and fifth importance with 6 of 27 (1.7 percent) of the total responses for all three. Stereo restitution had a tie for the ranks of second and fourth importance with 1 of 2 (0.3 percent) of the total responses for both. Rectification and resampling was ranked as having the third importance with 2 of 3 (0.6 percent) of the total responses. Mapping and cartography had a tie for the ranks of first and second importance with 13 of 40 (3.7 percent) of the total responses for both. Topography and digital elevation modeling was ranked as having the second importance with 21 of 56 (6.1 percent) of the total responses. Digital photogrammetry was ranked as having the fourth importance with 8 of 18 (2.3 percent) of the total responses. Project planning had a tie for the ranks of first and third importance with 12 of 41 (3.5 percent) of the total responses for both. Close-range photogrammetry was ranked as having the fourth importance with 3 of 8 (0.9 percent) of the total responses. Satellite photogrammetry was ranked as having the third importance with 5 of 13 (1.4 percent) of the total responses. Remote sensing was ranked as having the third importance with 5 of 15 (1.4 percent) of the total responses. Active sensing with LiDAR was ranked as having the fifth importance with 10 of 32 (2.9 percent) of the total responses. Applications was ranked as having the fifth importance with 10 of 19 (2.9 percent) of the total responses. (Note: Percentages are weighted to the total responses for importance ranking for daily operation.)

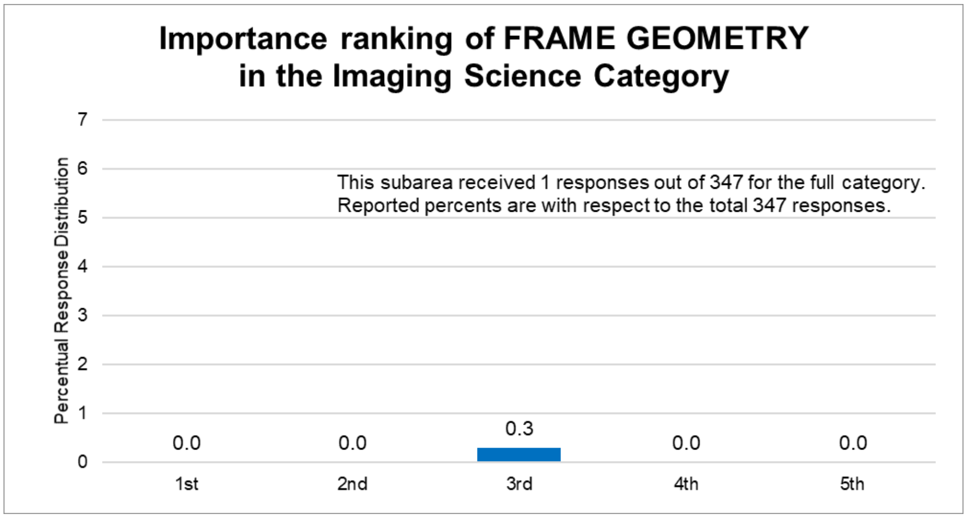


A. Importance ranking: Cameras and photography [2-05].

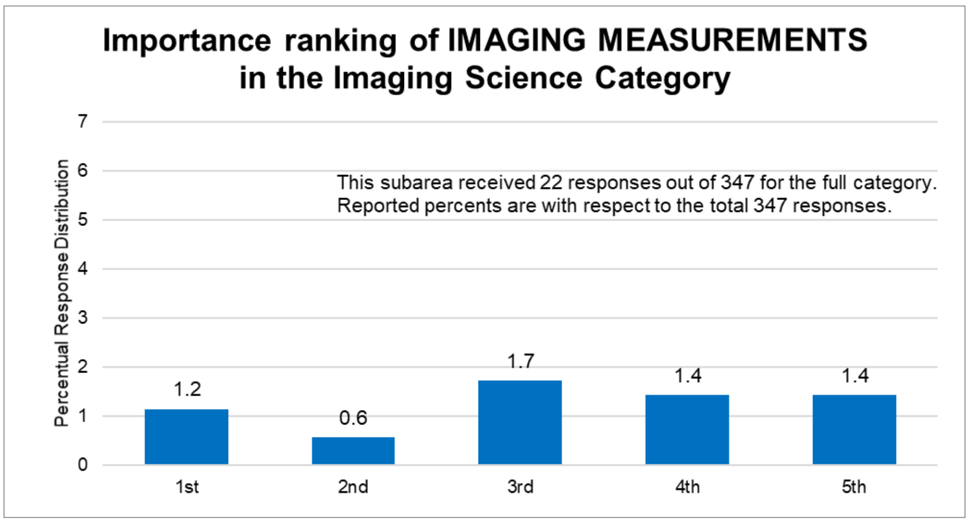


B. Importance ranking: Radiometry, detection, and sensing [2-05].

Figure 16. Bar graphs. Importance rankings in the imaging science category: (A) cameras and photography; (B) radiometry, detection, and sensing; (C) frame geometry; (D) imaging measurements; (E) stereoscopy and parallax; (F) math modeling and analytical photogrammetry; (G) computer vision; (H) estimation, adjustments, statistics, and error propagation; (I) stereo restitution; (J) rectification and resampling; (K) mapping and cartography; (L) topography and digital elevation modeling; (M) digital photogrammetry; (N) project planning; (O) close-range photogrammetry; (P) satellite photogrammetry; (Q) remote sensing; (R) active sensing with LiDAR; and (S) applications [2-05].

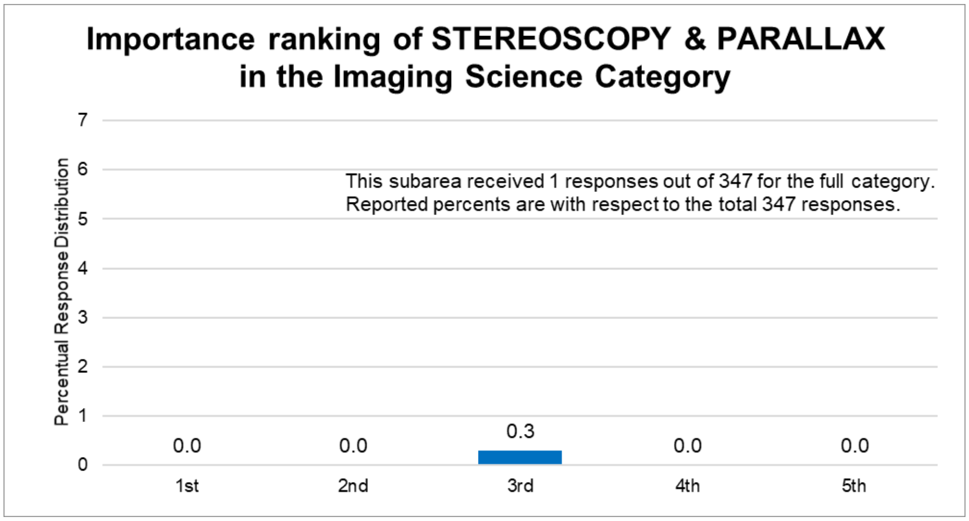


C. Importance ranking: Frame geometry [2-05].

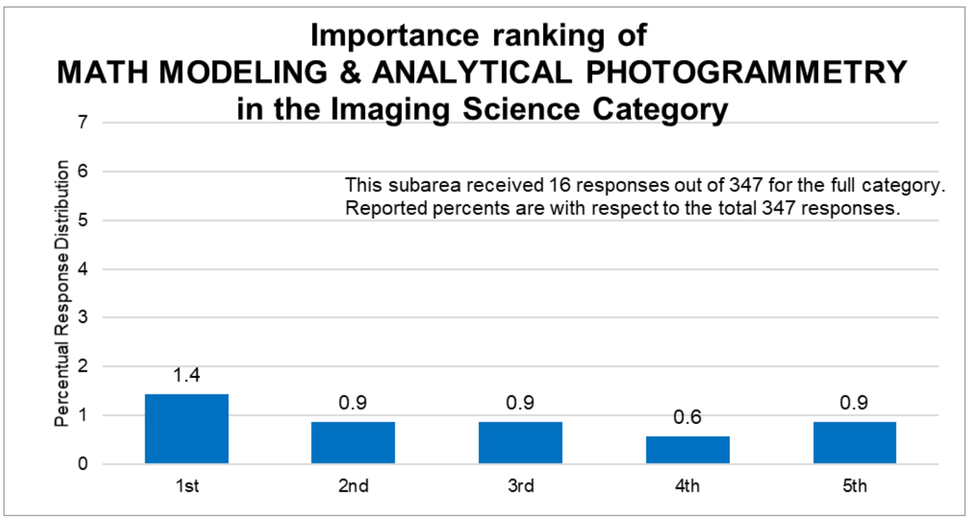


D. Importance ranking: Imaging measurements [2-05].

Figure 16. (Continued).

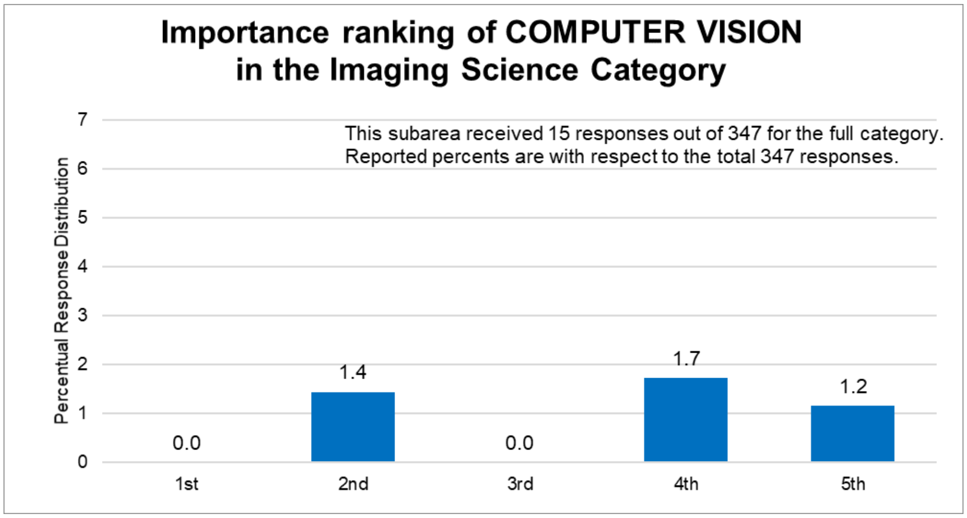


E. Importance ranking: Stereoscopy and parallax [2-05].

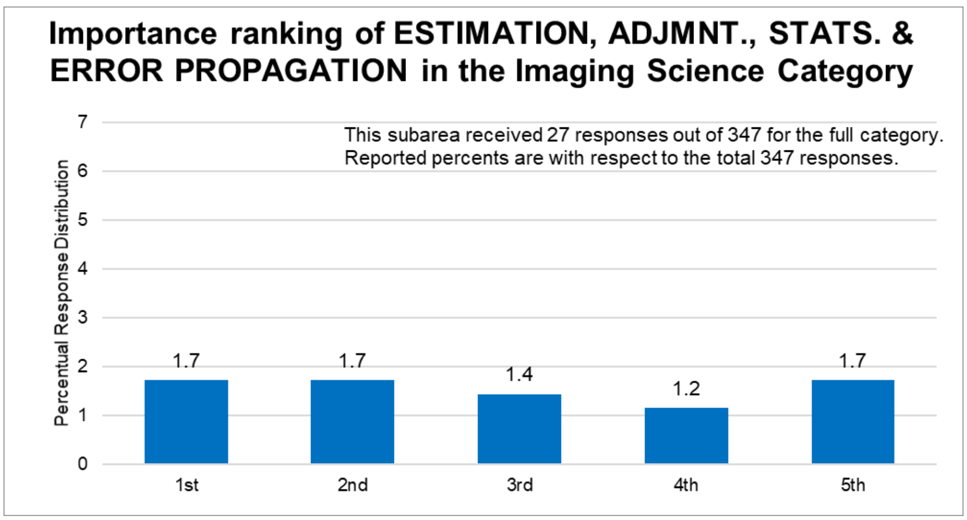


F. Importance ranking: Math modeling and analytical photogrammetry [2-05].

Figure 16. (Continued).

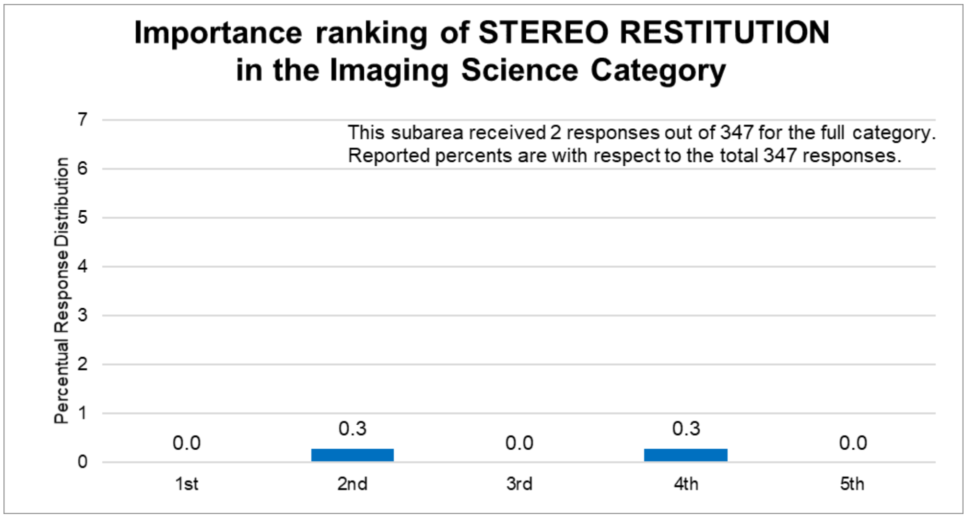


G. Importance ranking: Computer vision [2-05].

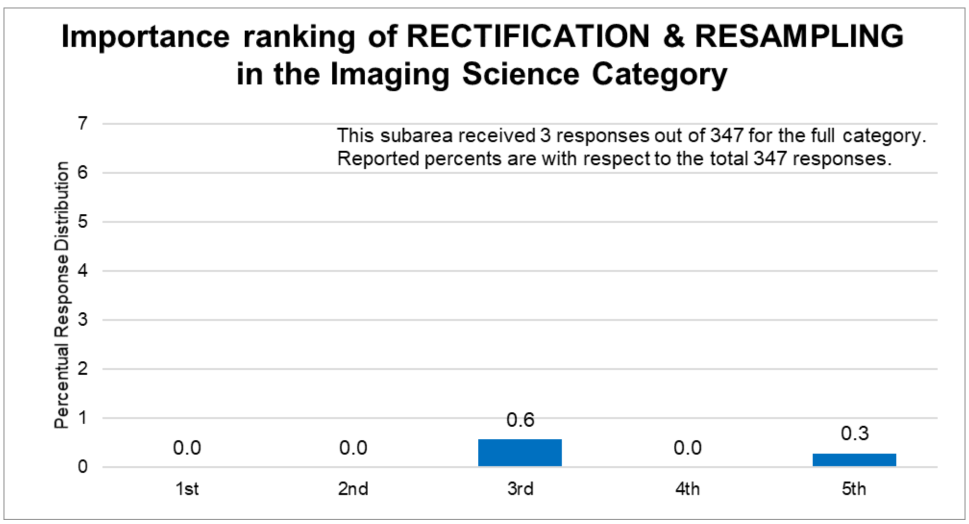


H. Importance ranking: Estimation, adjustments, statistics, and error propagation [2-05].

Figure 16. (Continued).

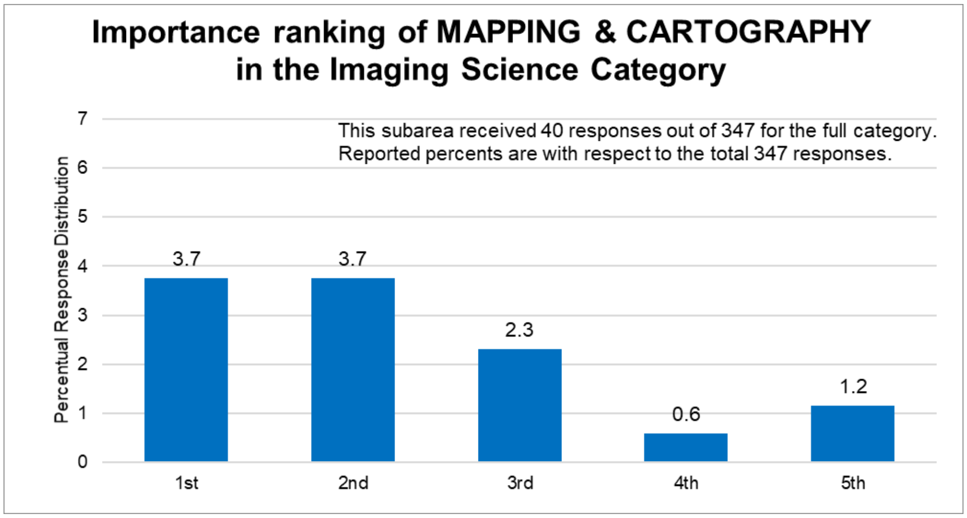


I. Importance ranking: Stereo restitution [2-05].

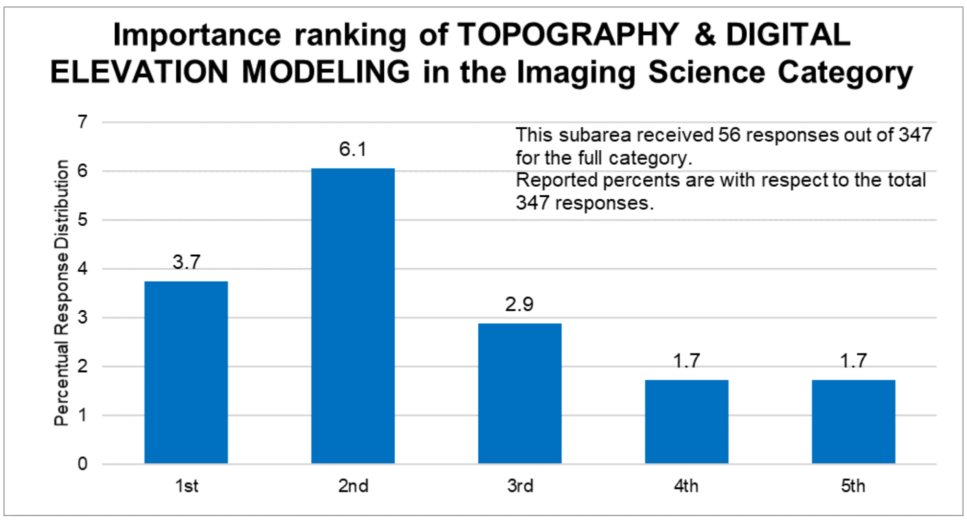


J. Importance ranking: Rectification and resampling [2-05].

Figure 16. (Continued).

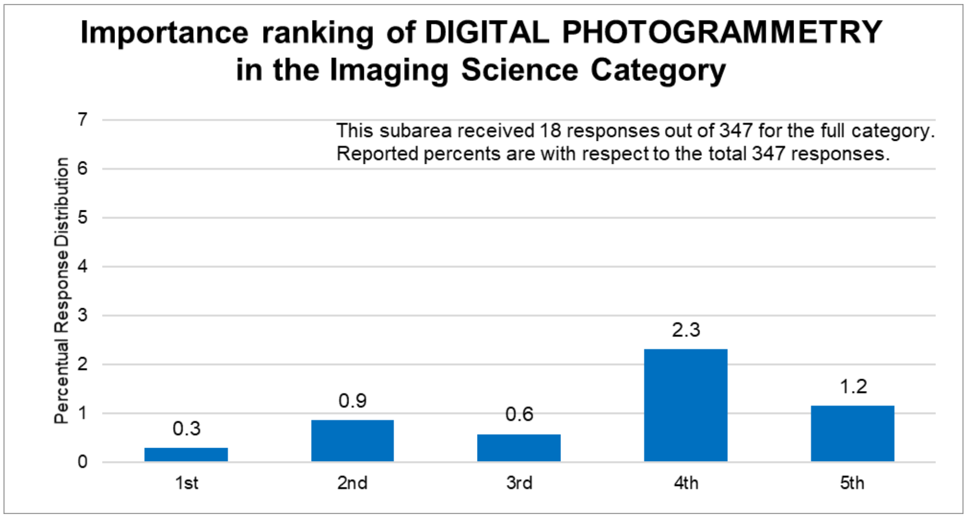


K. Importance ranking: Mapping and cartography [2-05].

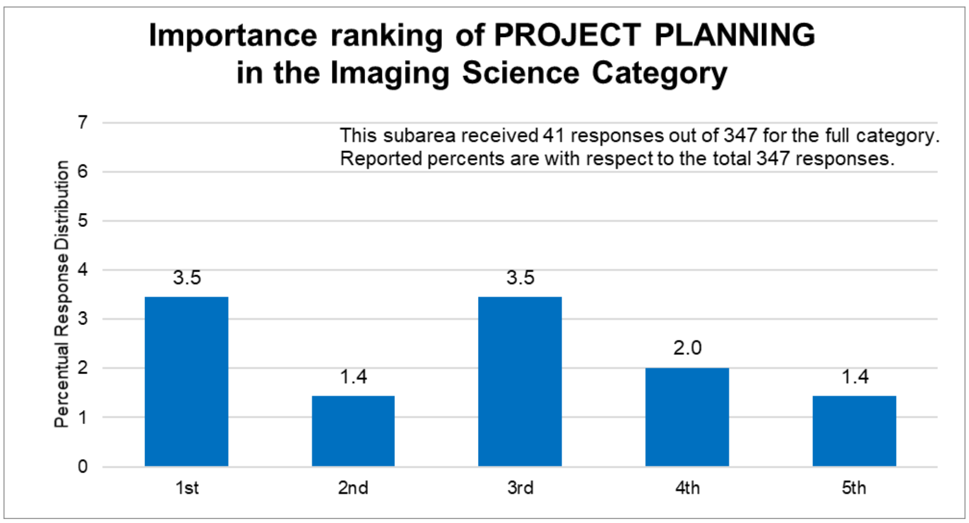


L. Importance ranking: Topography and digital elevation modeling [2-05].

Figure 16. (Continued).

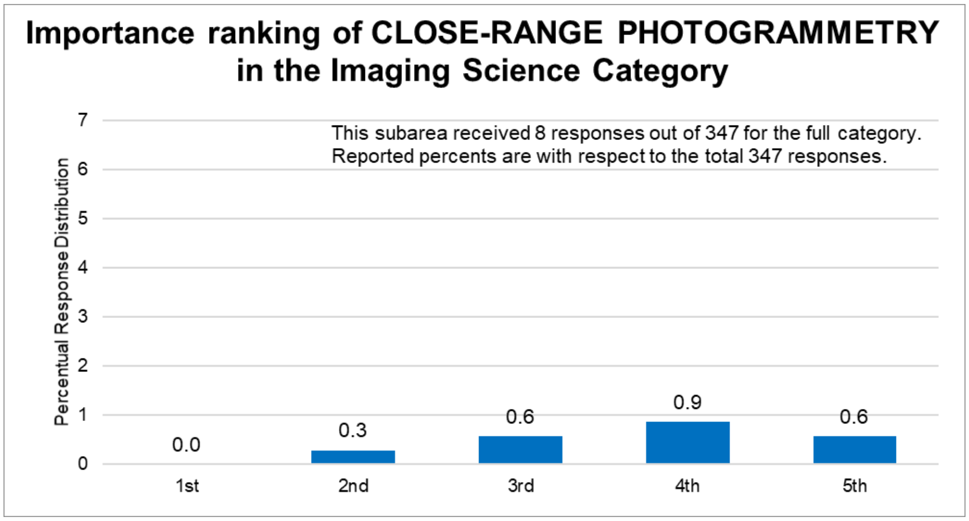


M. Importance ranking: Digital photogrammetry [2-05].

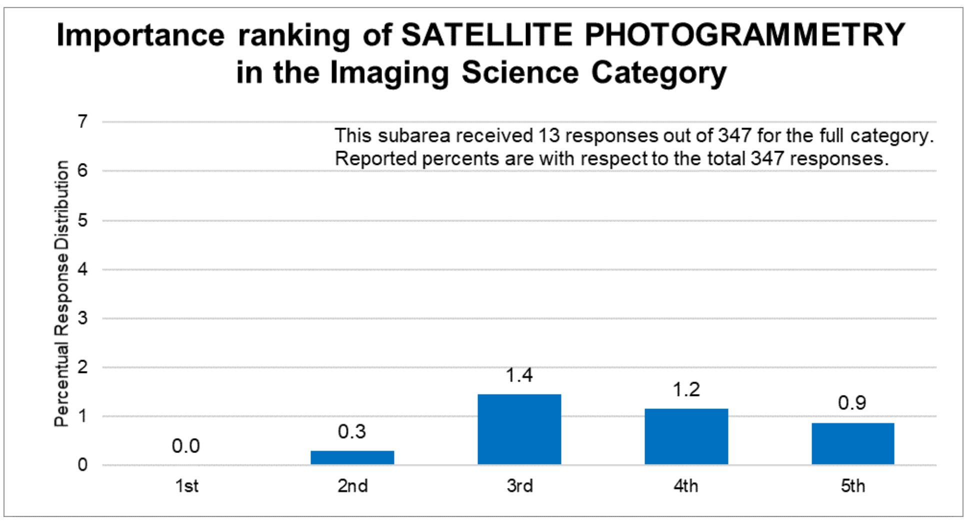


N. Importance ranking: Project planning [2-05].

Figure 16. (Continued).

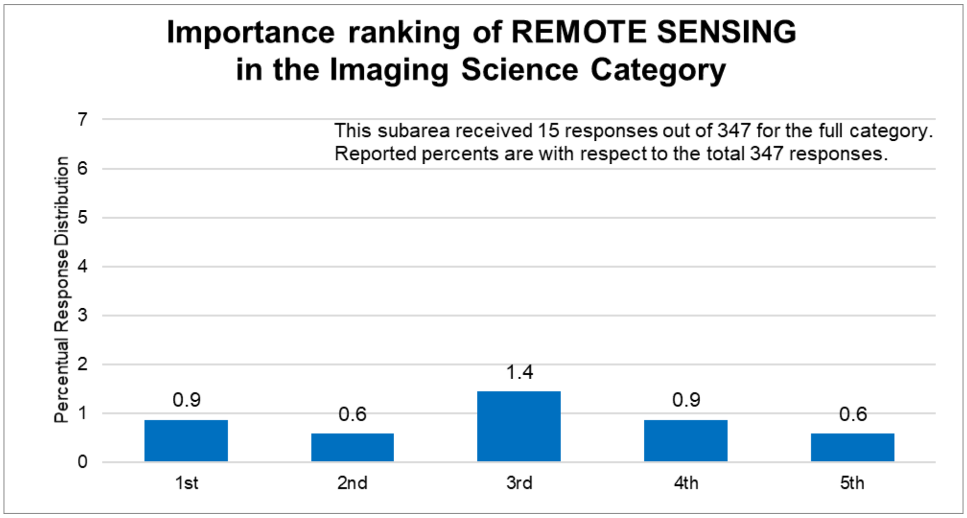


O. Importance ranking: Close-range photogrammetry [2-05].

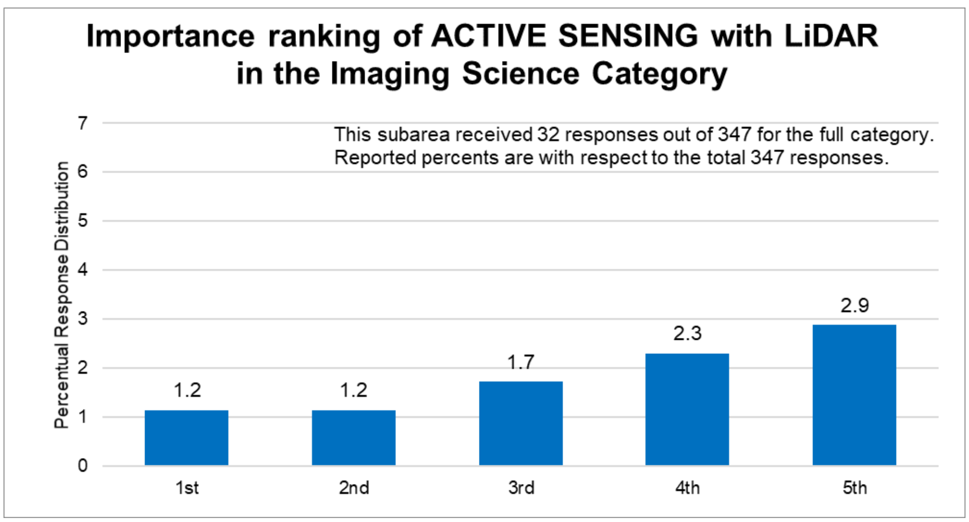


P. Importance ranking: Satellite photogrammetry (2-05).

Figure 16. (Continued).

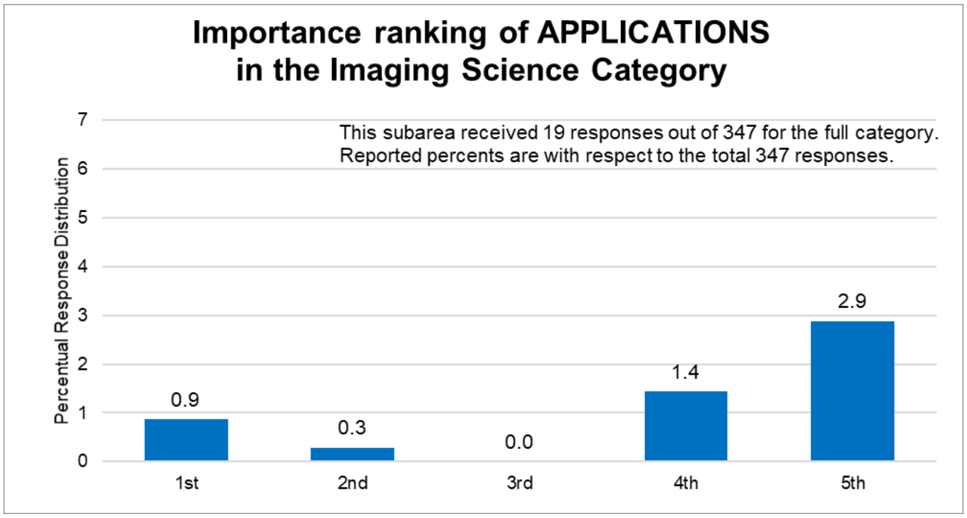


Q. Importance ranking: Remote sensing [2-05].



R. Importance ranking: Active sensing with LiDAR [2-05].

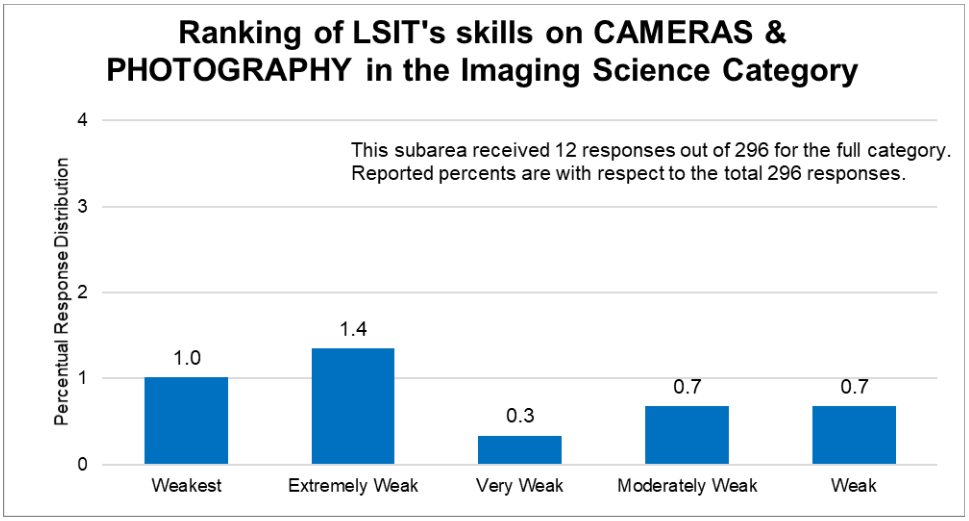
Figure 16. (Continued).



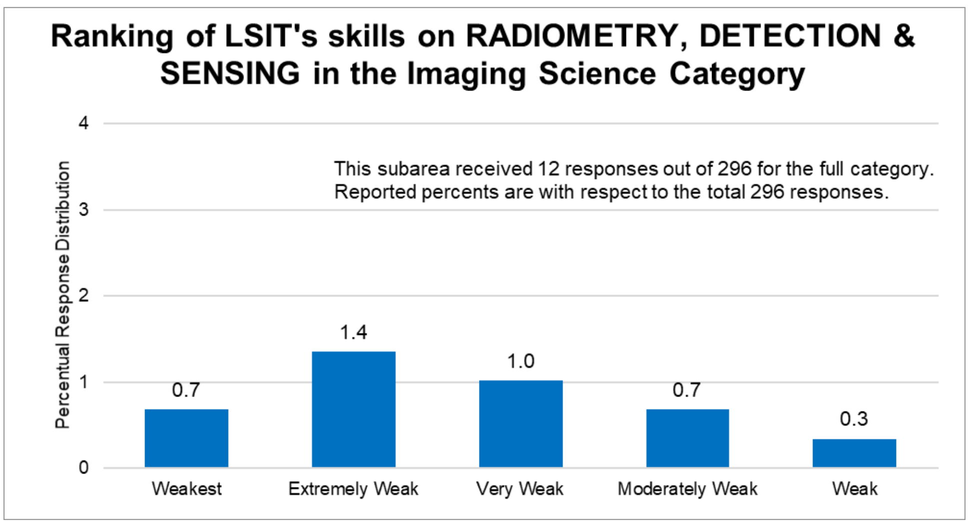
S. Importance ranking: Applications [2-05].

Figure 16. (Continued).

In question [2-06], cameras and photography was ranked as being extremely weak for the knowledge and skill for a newly licensed land surveyor in training for the imaging science category with 4 of 12 (1.4 percent) of 296 total responses (see figure 17). Radiometry, detection, and sensing was ranked as extremely weak with 4 of 12 (1.4 percent) of the total responses. Frame geometry was ranked as very weak with 5 of 12 (1.7 percent) of the total responses. Imaging measurements was ranked as weakest with 4 of 13 (1.4 percent) of the total responses. Stereoscopy and parallax was ranked as weak with 7 of 20 (2.4 percent) of the total responses. Mathematical modeling and analytical photogrammetry was ranked as moderately weak with 7 of 20 (2.4 percent) of the total responses. Computer vision had a tie for the ranks of weakest, very weak, moderately weak, and weak with 2 of 9 (0.7 percent) of the total responses for all four. Estimation, adjustment, statistics, and error propagation was ranked as very weak with 8 of 27 (2.7 percent) of the total responses. Stereo restitution was ranked as extremely weak with 5 of 18 (1.7 percent) of the total responses. Rectification and resampling had a tie for the ranks of very weak and weak with 3 of 11 (1.0 percent) of the total responses for both. Mapping and cartography was ranked as very weak with 9 of 21 (3.0 percent) of the total responses. Topography and digital elevation modeling was ranked as moderately weak with 10 of 27 (3.4 percent) of the total responses. Digital photogrammetry was ranked as extremely weak with 4 of 11 (1.4 percent) of the total responses. Project planning was ranked as weakest with 9 of 22 (3.0 percent) of the total responses. Close-range photogrammetry was ranked as moderately weak with 2 of 3 (0.7 percent) of the total responses. Satellite photogrammetry was ranked as very weak with 4 of 6 (1.4 percent) of the total responses. Remote sensing was ranked as weak with 6 of 12 (2.0 percent) of the total responses. Active sensing with LiDAR had a tie for the ranks of weakest and moderately weak with 6 of 23 (2.0 percent) of the total responses for both. Applications was ranked as extremely weak with 6 of 17 (2.0 percent) of the total responses. (Note: Percentages are weighted to the total responses for weakness ranking for a newly licensed LSIT in imaging science.)

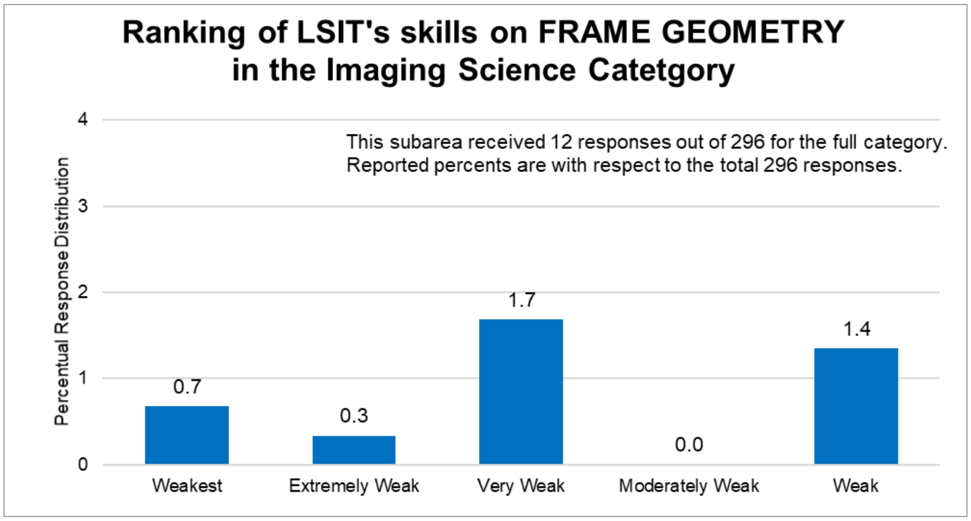


A. Weakness ranking: Cameras and photography [2-06].

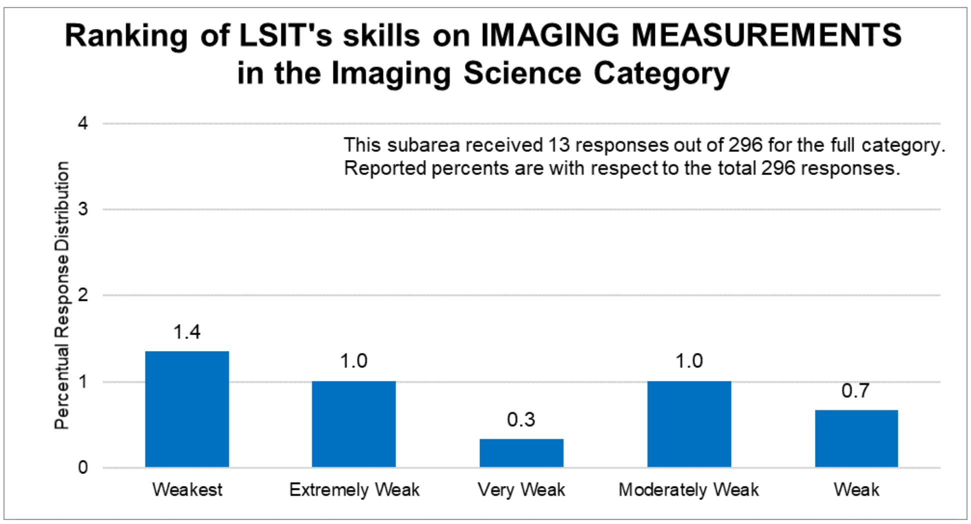


B. Weakness ranking: Radiometry, detection, and sensing [2-06].

Figure 17. Bar graphs. Weakness ranking in the imaging science category: (A) cameras and photography, (B) radiometry, detection, and sensing; (C) frame geometry; (D) imaging measurements; (E) stereoscopy and parallax; (F) math modeling and analytical photogrammetry; (G) computer vision; (H) estimating, adjustments, statistics, and error propagation; (I) stereo restitution; (J) rectification and resampling; (K) mapping and cartography; (L) topography and digital elevation modeling; (M) digital photogrammetry; (N) project planning; (O) close-range photogrammetry; (P) satellite photogrammetry; (Q) remote sensing; (R) active sensing with LiDAR; and (S) applications [2-06].

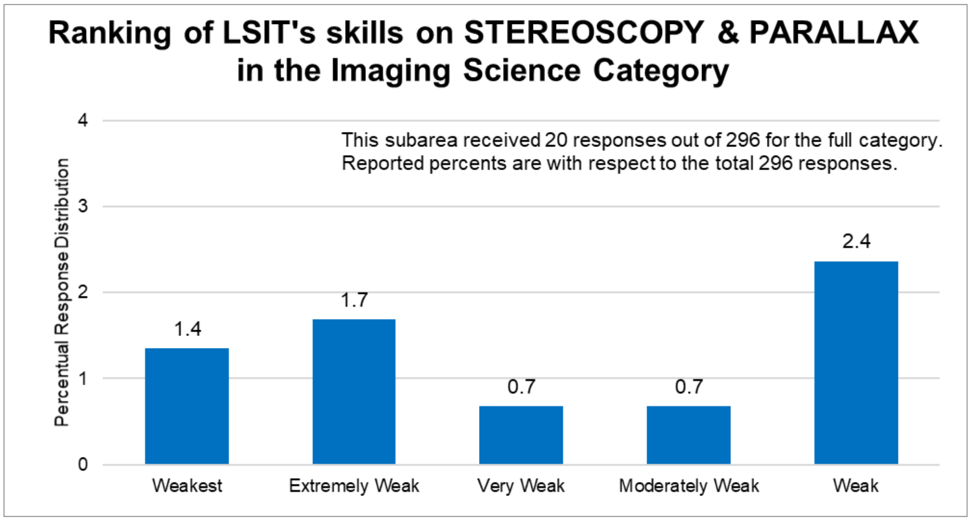


C. Weakness ranking: Frame geometry [2-06].

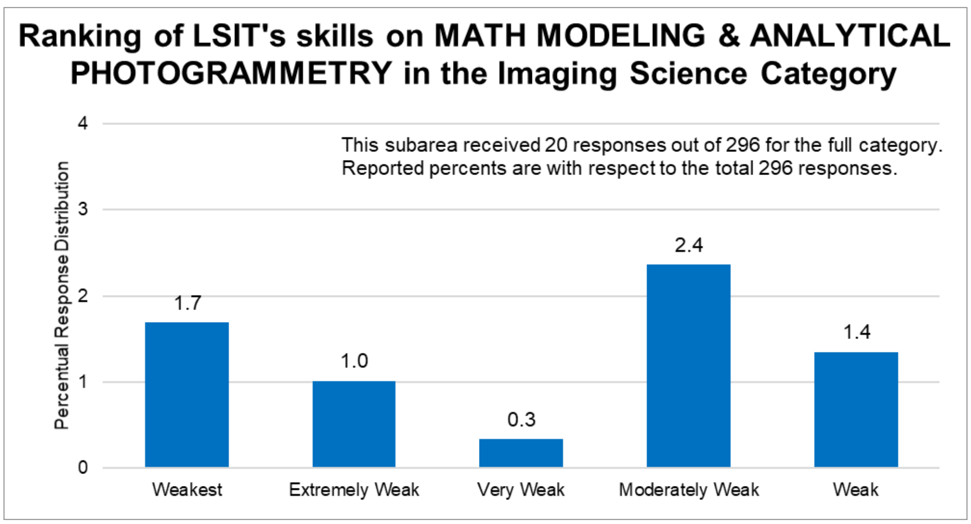


D. Weakness ranking: Imaging measurements [2-06].

Figure 17. (Continued).

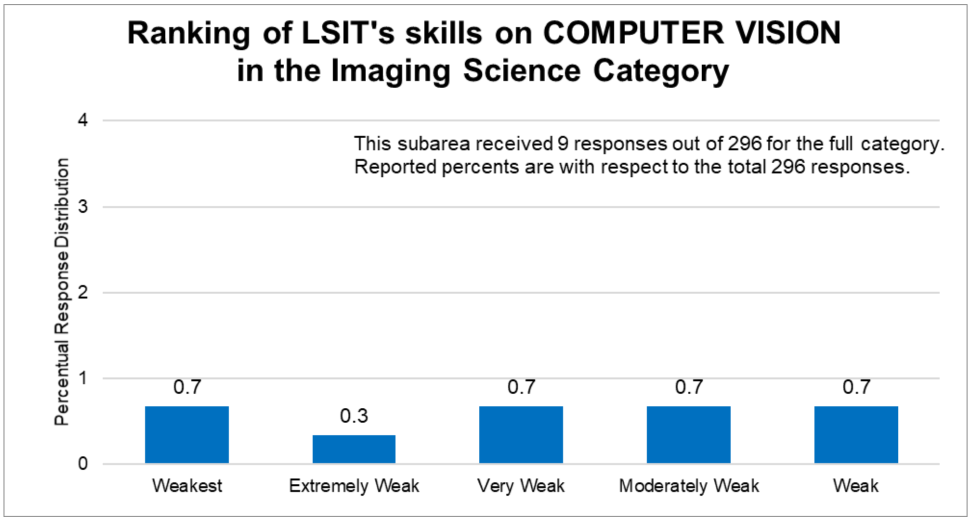


E. Weakness ranking: Stereoscopy and parallax [2-06].

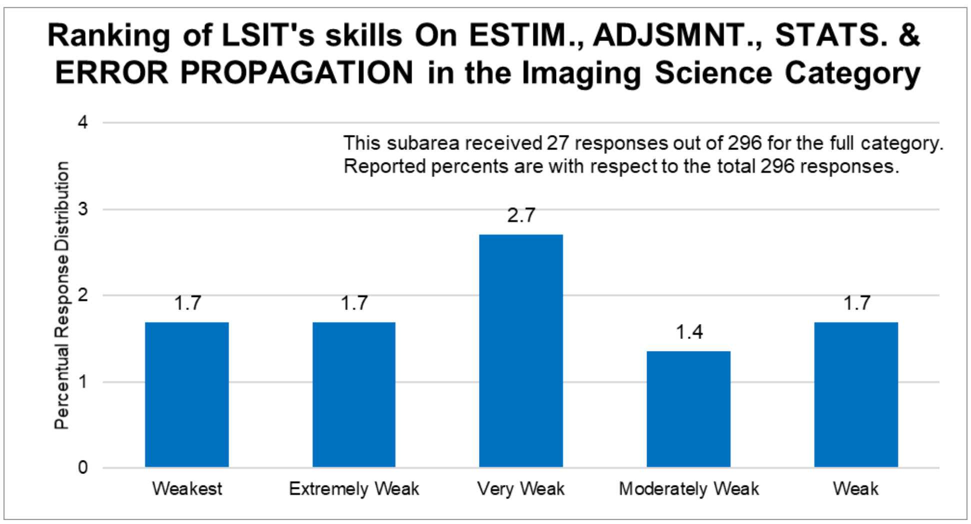


F. Weakness ranking: Math modeling and analytical photogrammetry [2-06].

Figure 17. (Continued).

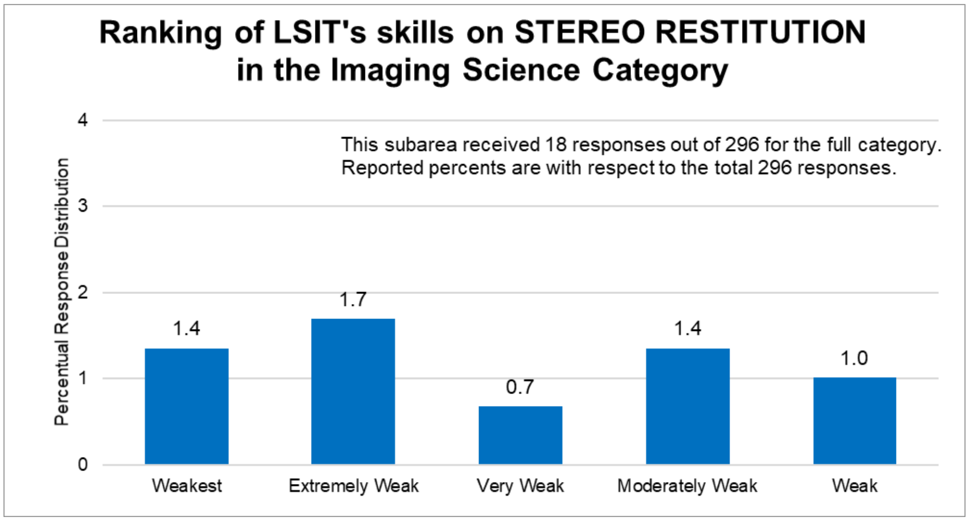


G. Weakness ranking: Computer vision [2-06].

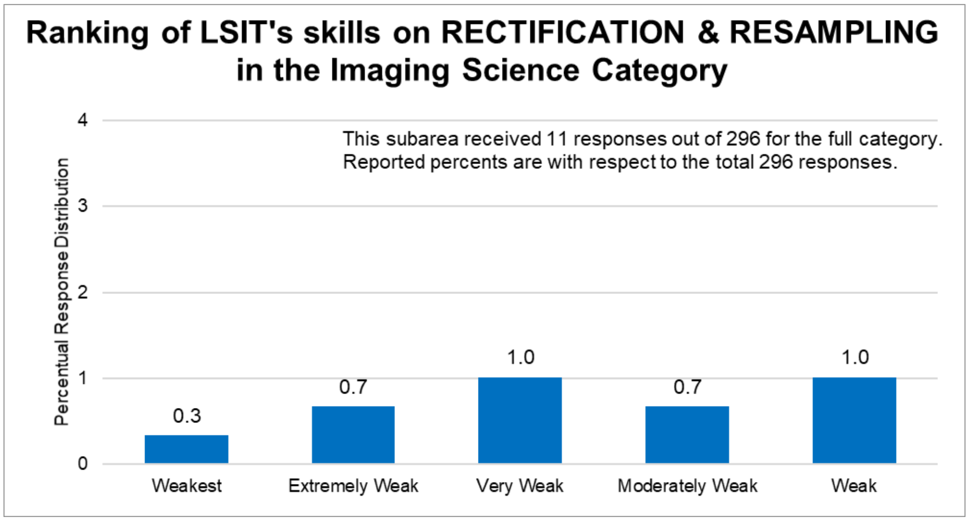


H. Weakness ranking: Estimating, adjustments, statistics, and error propagation [2-06].

Figure 17. (Continued).

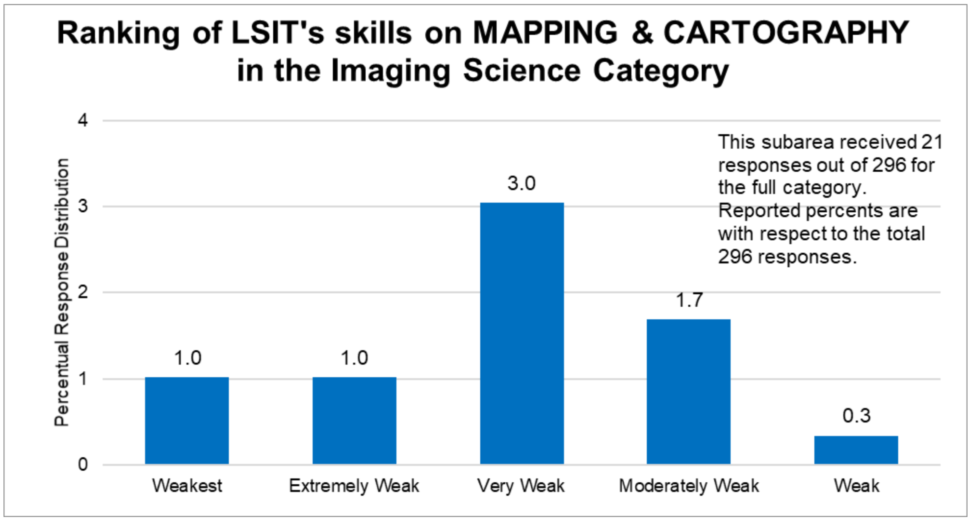


I. Weakness ranking: Stereo restitution [2-06].

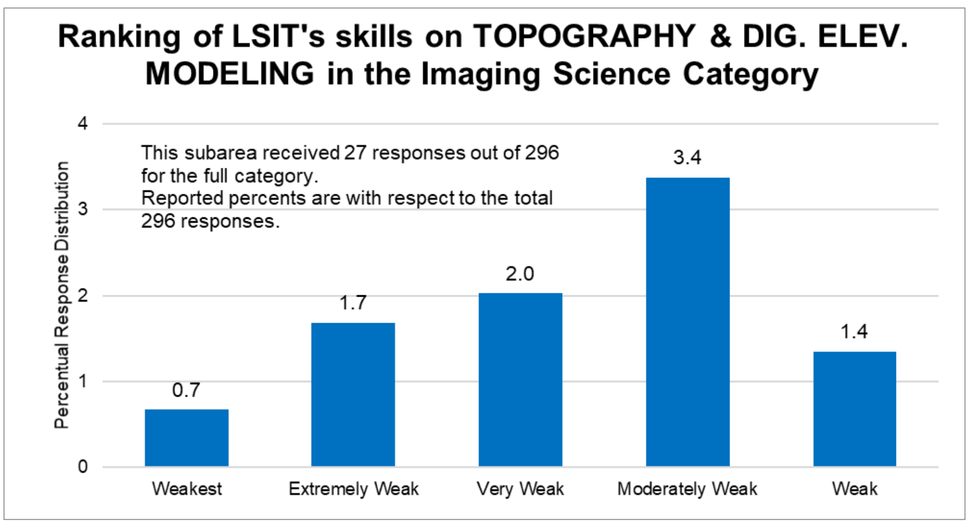


J. Weakness ranking: Rectification and resampling [2-06].

Figure 17. (Continued).

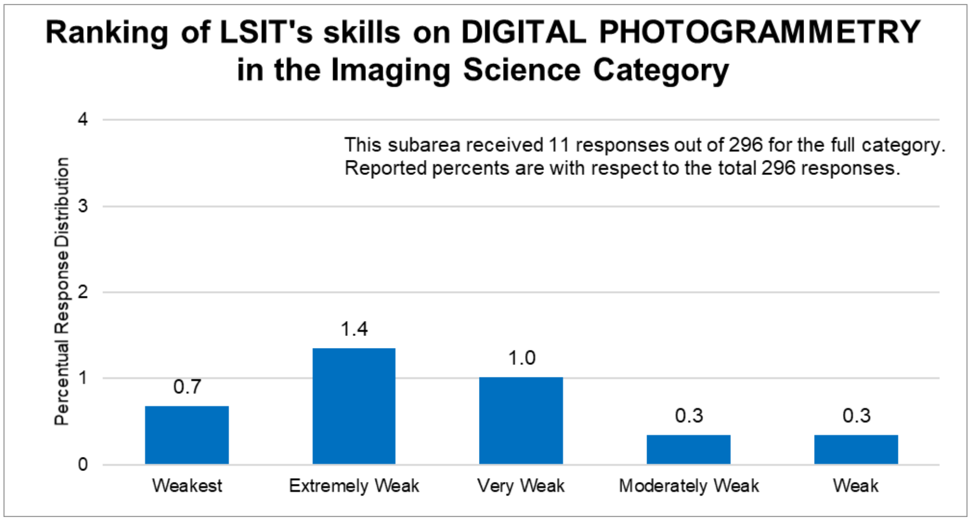


K. Weakness ranking: Mapping and cartography [2-06].

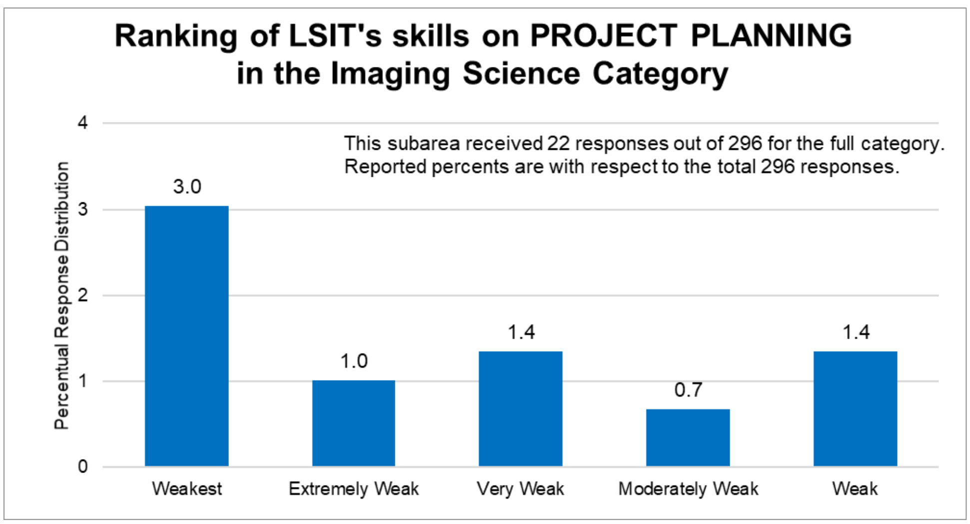


L. Weakness ranking: Topography and digital elevation modeling [2-06].

Figure 17. (Continued).

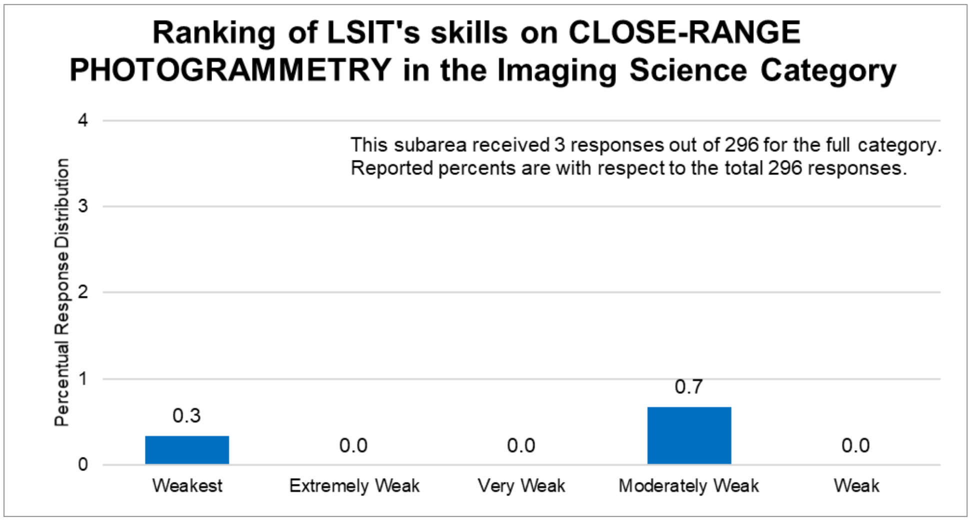


M. Weakness ranking: Digital photogrammetry [2-06].

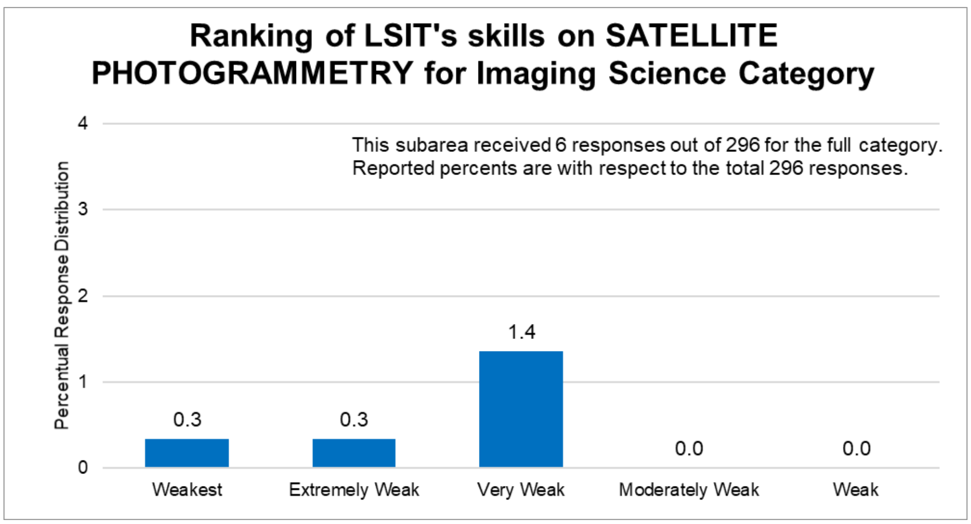


N. Weakness ranking: Project planning [2-06].

Figure 17. (Continued).

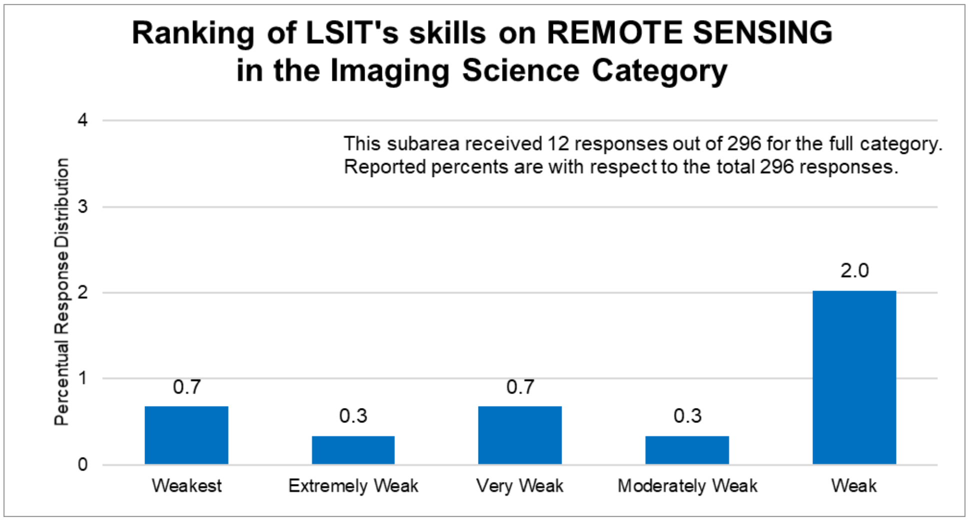


O. Weakness ranking: Close-range photogrammetry [2-06].

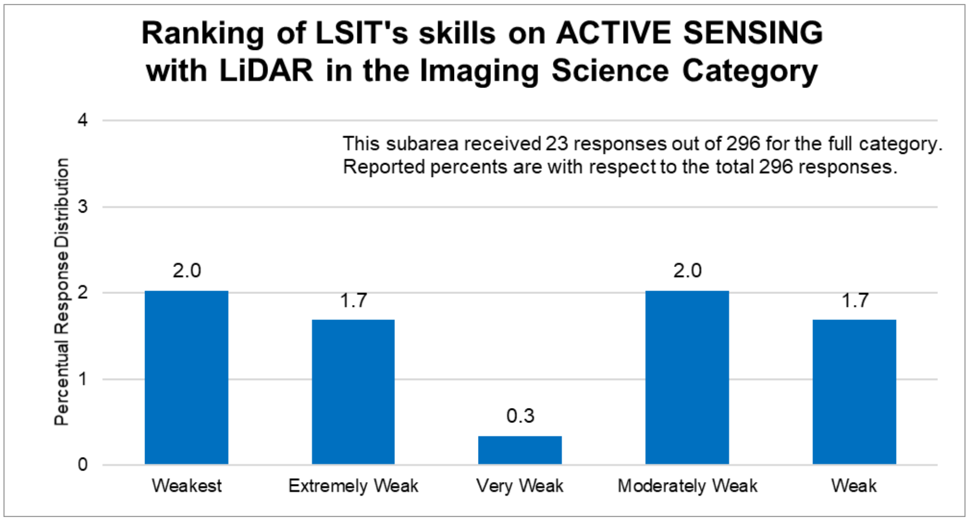


P. Weakness ranking: Satellite photogrammetry [2-06].

Figure 17. (Continued).

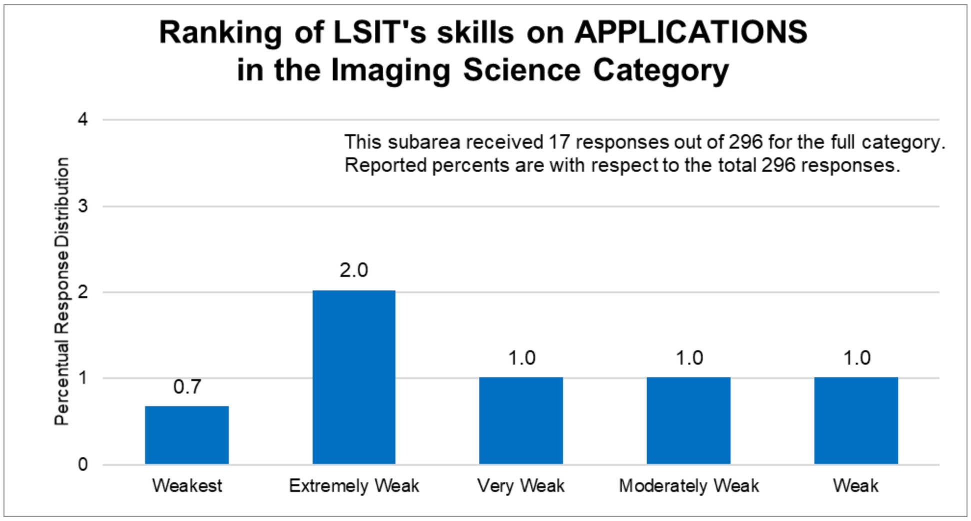


Q. Weakness ranking: Remote sensing [2-06].



R. Weakness ranking: Active sensing with LiDAR [2-06].

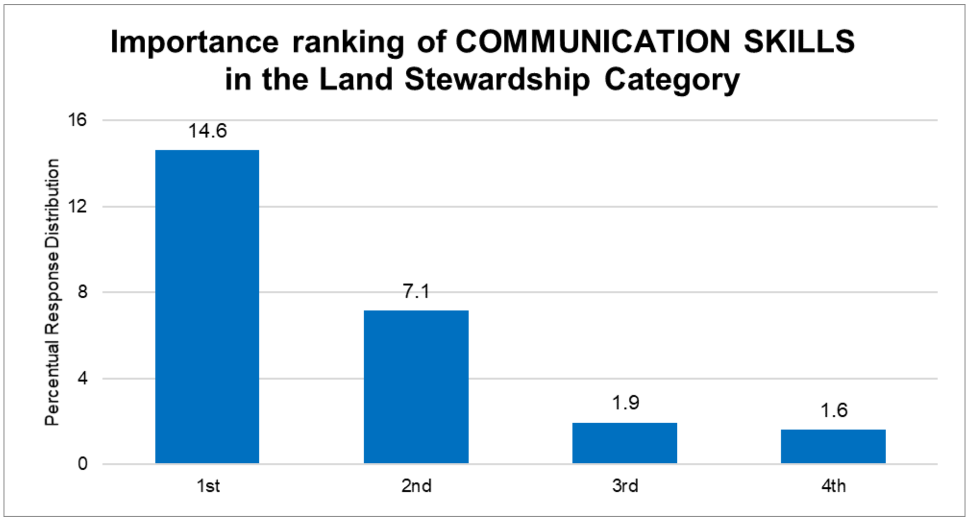
Figure 17. (Continued).



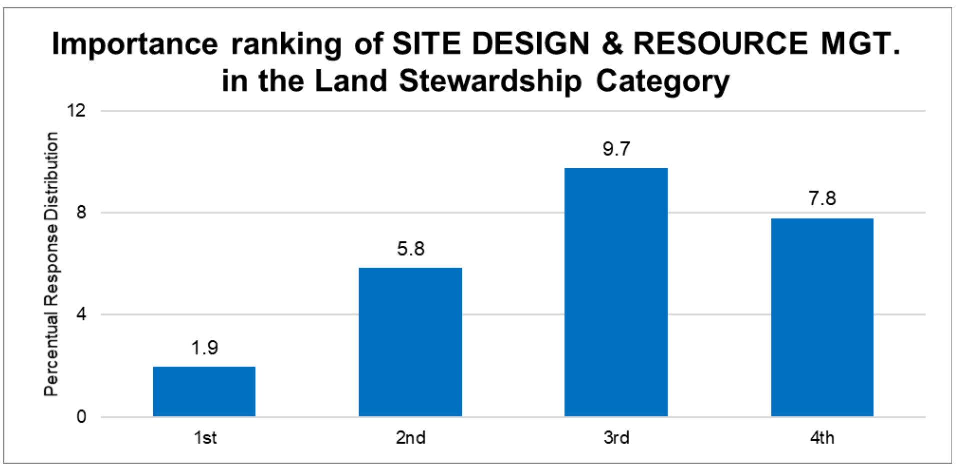
S. Weakness ranking: Applications [2-06].

Figure 17. (Continued).

In question [2-07], communication skills was ranked as having the first importance for the daily operation within surveying geomatics for the land stewardship category with 45 of 78 (14.6 percent) of the total responses for this question (see figure 18). Site design and resource management was ranked as having the third importance with 30 of 78 (9.7 percent) of the total responses. Site constraints was ranked as having the fourth importance with 32 of 75 (10.4 percent) of the total responses. Project administration, management, and organization was ranked as having the second importance with 30 of 77 (9.7 percent) of the total responses. (Note: Percentages are weighted to the total responses for weakness ranking for daily operation within S-G in land stewardship.)

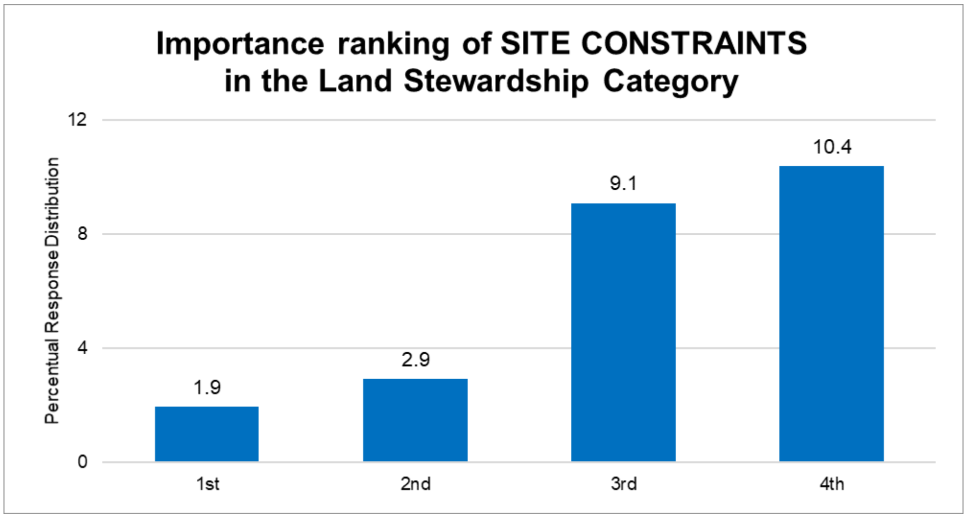


A. Importance ranking: Communication skills [2-07].

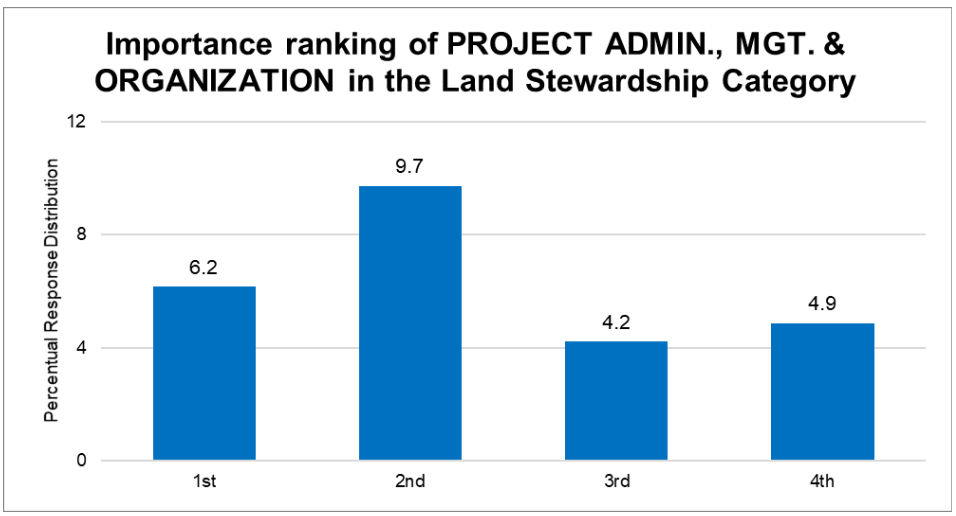


B. Importance ranking: Site design and resource management [2-07].

Figure 18. Bar graphs. Importance ranking in the land stewardship category: (A) communication skills; (B) site design and resource management; (C) site constraints; and (D) project administration, management, and organization [2-07].



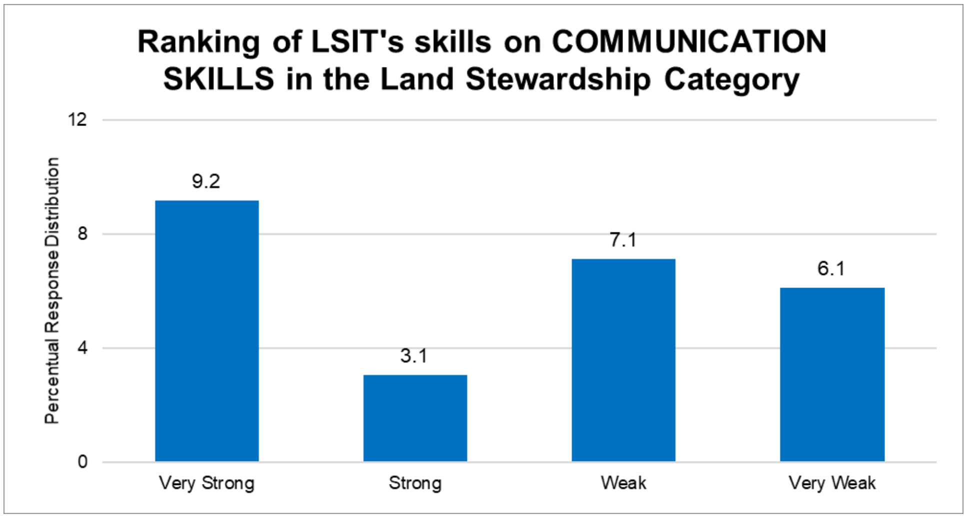
C. Importance ranking: Site constraints [2-07].



D. Importance ranking: Project administration, management, and organization [2-07].

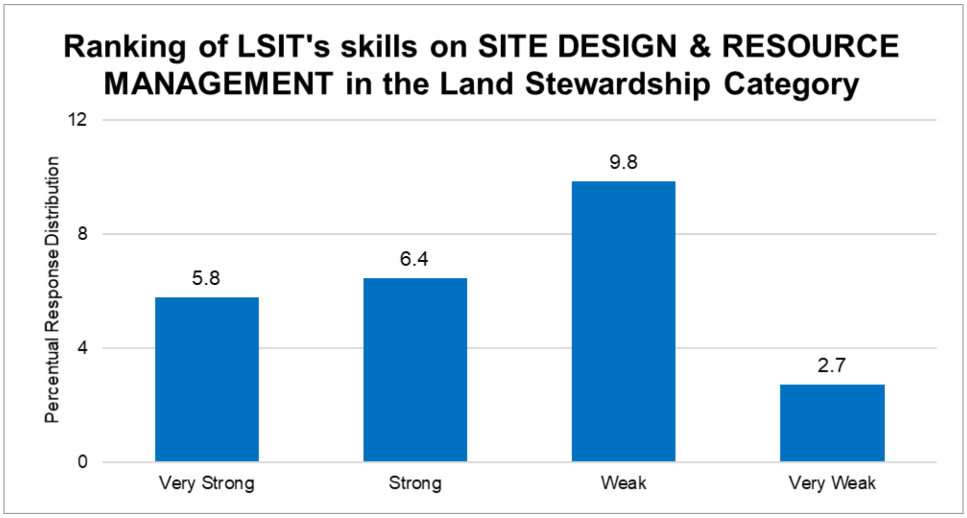
Figure 18. (Continued).

In question [2-08], communication skills was ranked as being very strong for the knowledge and skill for a newly licensed land surveyor in training for the land stewardship category with 27 of 75 (9.2 percent) of the total responses (see figure 19). Site design and resource management was ranked as weak with 29 of 73 (9.8 percent) of the total responses. Site constraints was ranked as strong with 27 of 74 (9.2 percent) of the total responses. Project administration, management, and organization was ranked as very weak with 28 of 73 (9.5 percent) of the total responses. (Note: Percentages are weighted to the total responses for strength ranking for daily operation within S-G in land stewardship.)

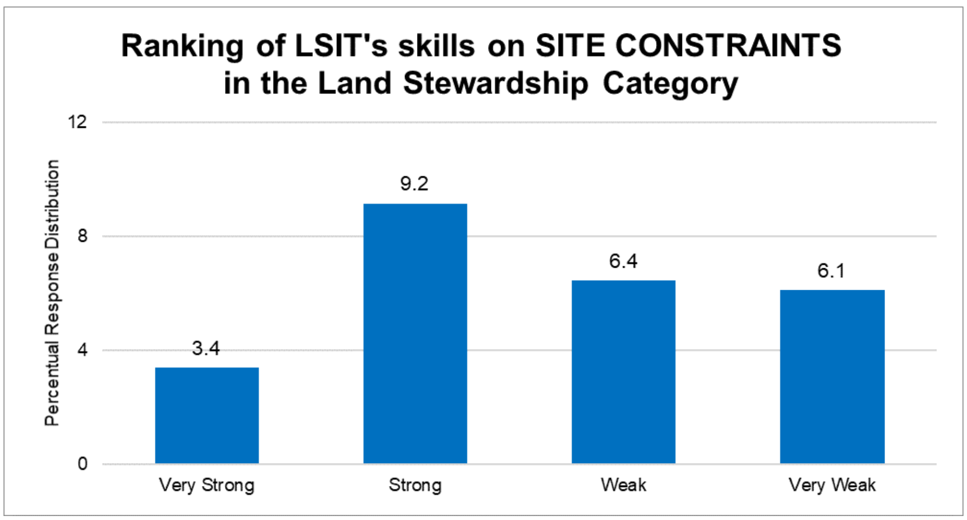


A. Strength ranking: Communication [2-08].

Figure 19. Bar graphs. Strength rankings in the land stewardship category: (A) communication; (B) site design and resource management; (C) site constraints; and (D) project administration, management, and organization [2-08].

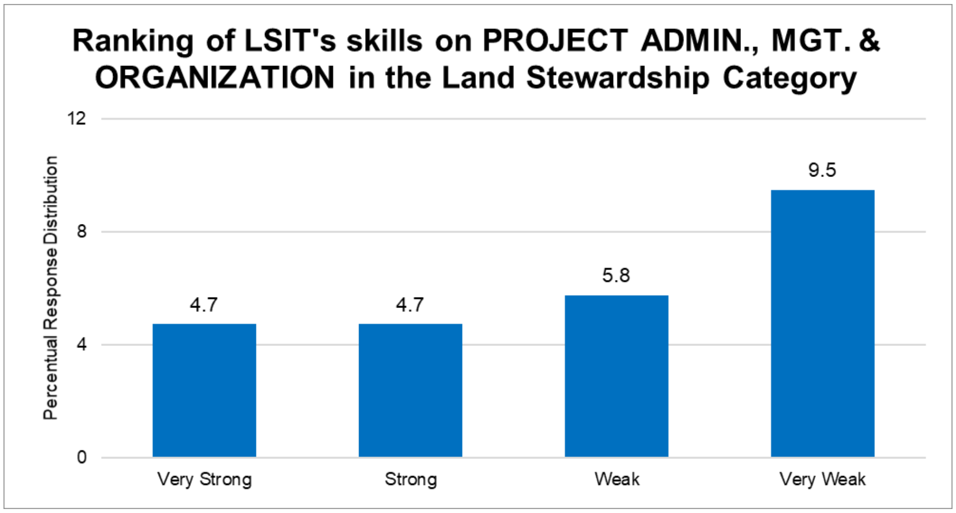


B. Strength ranking: Site design and resource management [2-08].



C. Strength ranking: Site constraints [2-08].

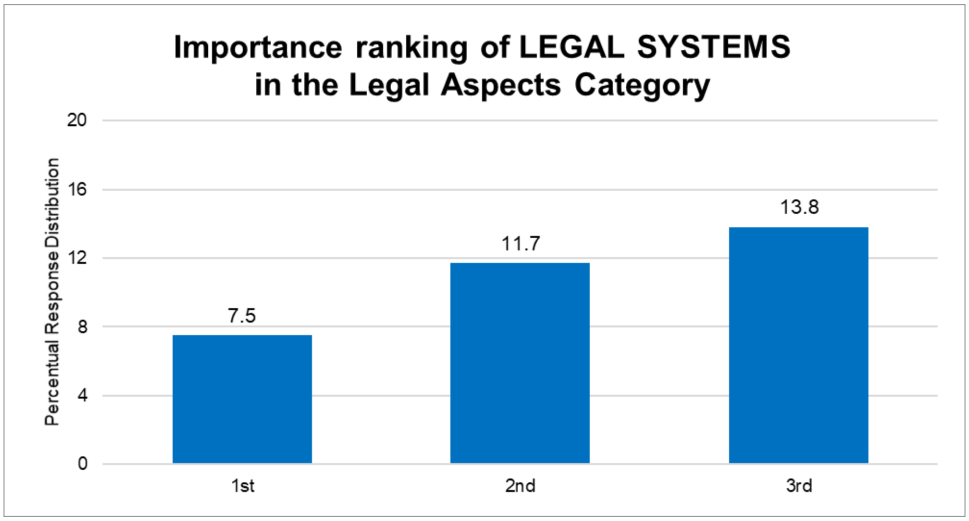
Figure 19. (Continued).



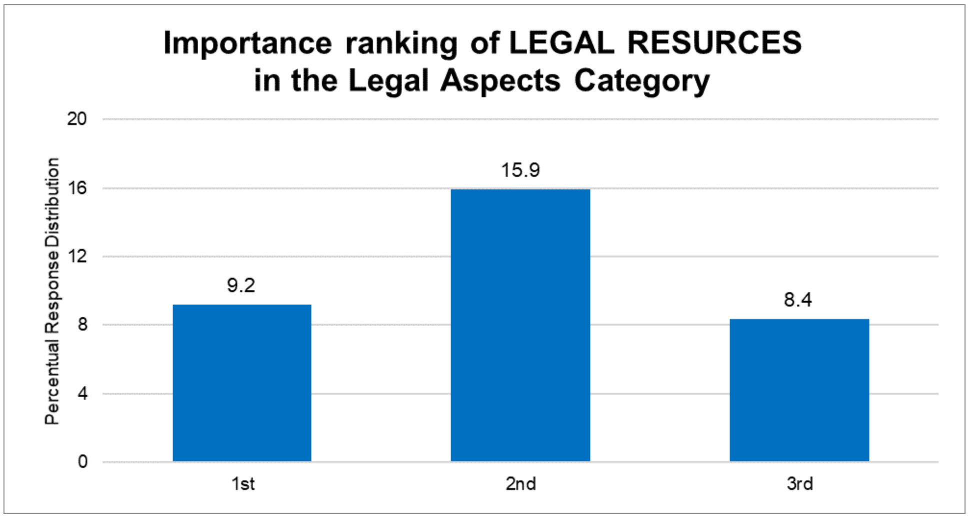
D. Strength ranking: Project administration, management, and organization [2-08].

Figure 19. (Continued).

In question [2-09], legal systems was ranked as having the third importance to the daily operation within surveying geomatics for the legal aspects category with 33 of 79 (13.8 percent) of the total responses (see figure 20). Legal resources was ranked as having the second importance with 38 of 80 (15.9 percent) of the total responses. Law and business was ranked as having the first importance with 41 of 80 (17.2 percent) of the total responses. (Note: Percentages are weighted to the total responses for importance ranking for daily operation within S-G in legal systems.)

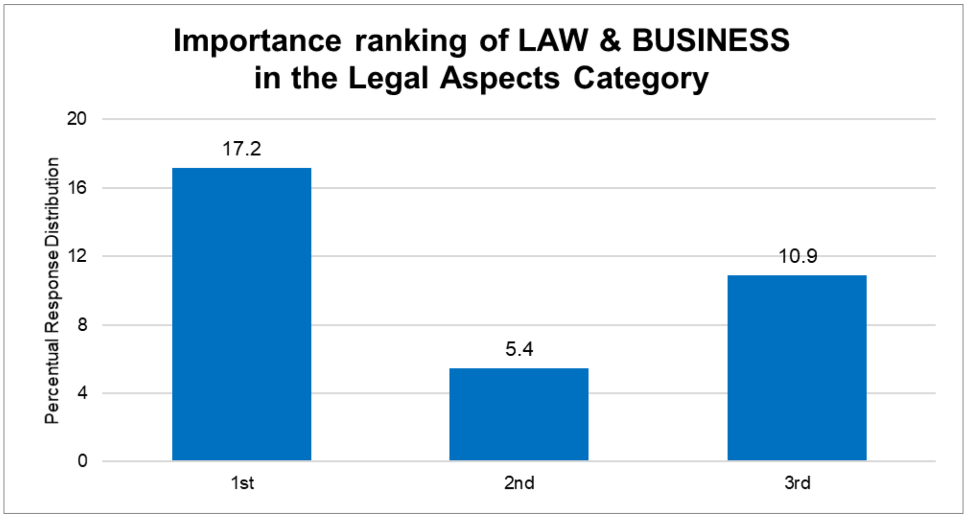


A. Importance ranking: Legal systems [2-09].



B. Importance ranking: Legal resources [2-09].

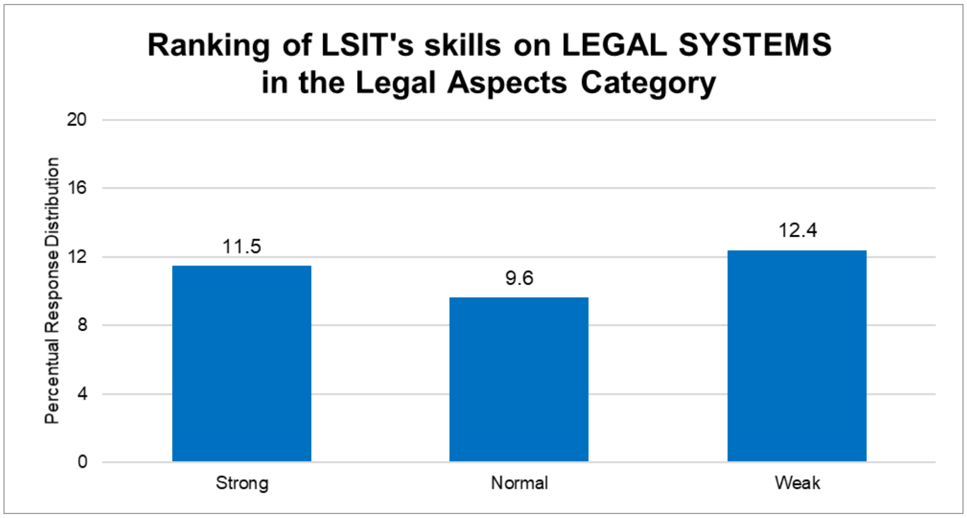
Figure 20. Bar graphs. Importance ranking in the legal aspects category: (A) legal systems, (B) legal resources, and (C) law and business [2-09].



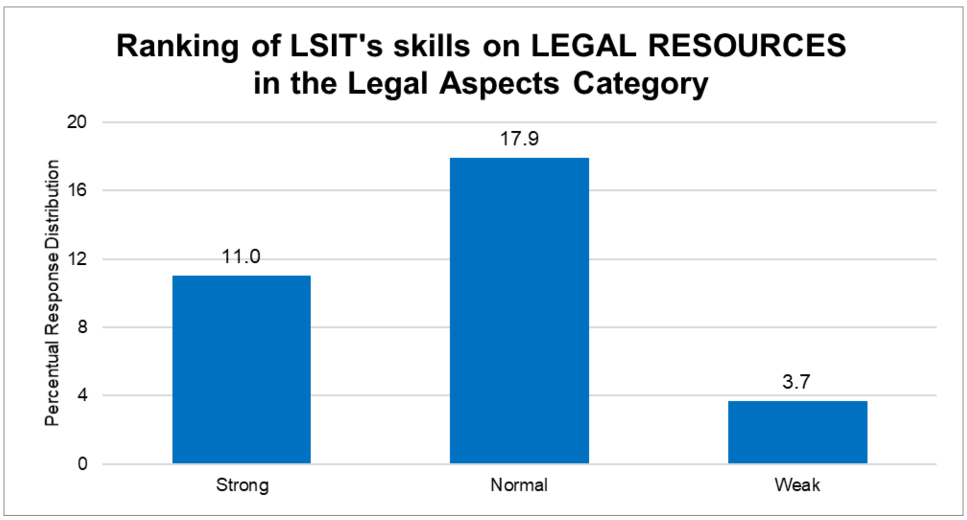
C. Importance ranking: Law and business [2-09].

Figure 20. (Continued).

In question [2-10], legal systems was ranked as being weak for the knowledge and skill for a newly licensed land surveyor in training for the legal aspects category with 27 of 73 (12.4 percent) of the total responses (see figure 21). Legal resources was ranked as normal with 39 of 71 (17.9 percent) of the total responses. Law and business was ranked as weak with 40 of 74 (18.3 percent) of the total responses. (Note: Percentages are weighted to the total responses for weakness ranking for a newly licensed LSIT in the area of legal aspects.)

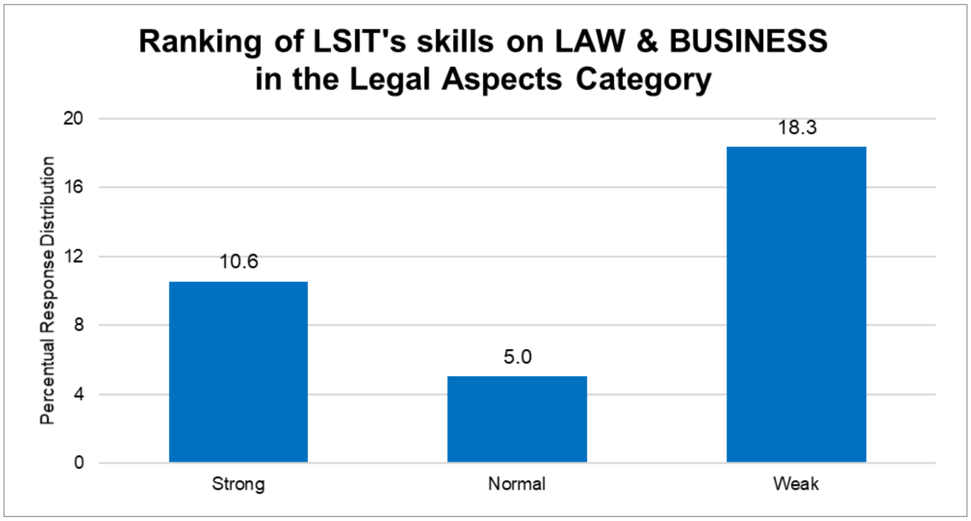


A. Weakness ranking: Legal systems [2-10].



B. Weakness ranking: Legal resources [2-10].

Figure 21. Bar graphs. Weakness ranking in the legal aspects category: (A) legal systems, (B) legal resources, and (C) law and business [2-10].



C. Weakness ranking: Law and business [2-10].

Figure 21. (Continued).

Summarizing the results from the questions focused on knowledge and skills needs, the research team broke down the questions in terms of how they were analyzed. Thus, the substantive results considered include the following:

- Positioning: Significant importance for daily S-G operation (1st, 2nd, and 3rd ranking) components as follows:
    - Measurements.
    - Data analysis.
    - Adjustments.
- Positioning: Significant importance for new LSIT/graduate skills (1st, 2nd, and 3rd ranking) components as follows:
    - Measurements.
    - Data analysis.
    - Adjustments.

- Geospatial science: Significant importance for daily S-G operation (1st, 2nd, and 3rd ranking) components as follows:
    - Geospatial data.
    - Analytical methods.
    - Data modeling.
- Geospatial science: Weakness ranking for new LSIT/graduate skills (1st, 2nd, and 3rd weakest ranking) components as follows:
    - Management and organizational aspects.
    - Analytical methods.
    - Manipulation.
- Imaging science: Significant importance for daily S-G operation (two rankings were notable) components as follows:
    - Topography and digital elevation models.
    - Project planning.
- Imaging science: Weakness ranking for new LSIT/graduate skills (1st, 2nd, and 3rd weakest ranking) components as follows:
    - Project planning.
    - Mapping and cartography.
    - Estimation, adjustments, statistics, and error propagation.
- Land stewardship: Significant importance for daily S-G operation (1st, 2nd, and 3rd ranking) components as follows:
    - Communications skills.
    - Project administration, management, and organization.

    - Site design and resource management.
- Land stewardship: Significant importance for new LSIT/graduate skills (1st, 2nd, and 3rd ranking) components as follows:
    - Communication skills.
    - Site design and resource management.
    - Site constraints.
- Legal aspects: Significant importance for daily S-G operation (1st, 2nd, and 3rd ranking) components as follows:
    - Law and business.
    - Legal resources.
    - Legal systems.

DATA ANALYSIS: S-G POSITION NEEDS

The analysis of the results obtained from the questionnaire survey from surveying–geomatics professionals is crucial to reaching an understanding of the status and needs for S-G employment in Georgia. In this section, the researchers further strengthen the importance of the questions and expound on the responses and comments from the survey. It is essential to be able to tackle the challenges associated with position availability and ultimately proffer a solution to the concerns perceived to be facing the field of surveying–geomatics with regard to employment.

From the survey results, many professionals thought that the minimum qualification to be a land surveyor in Georgia is the bachelor's degree. About 51 percent believed this to be true. However, 29.3 percent of the professionals did not agree, as they were of the opinion that several roles only require an associate degree if the employee is able to demonstrate the ability to carry out the position's duties. All employees in S-G get additional training and acquire more skills on the job. Additionally, 19.5 percent of respondents to question [3.01] were indifferent about the minimum qualification because they think it takes more than just a degree to become a good surveyor. However, some added that a large portion of surveyors in Georgia do not possess sufficient basic education to understand the basic principles of land surveying. The detailed feedback is shown in figure 22.

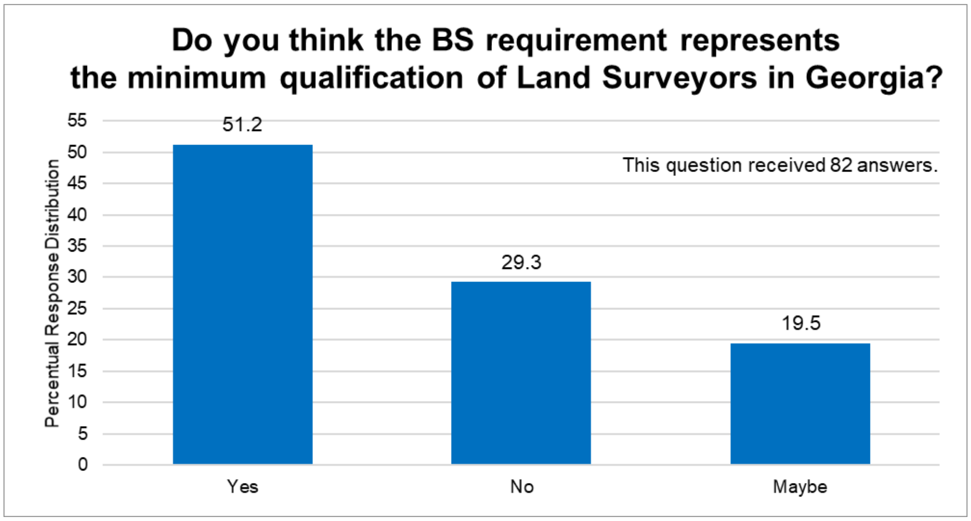


Figure 22. Bar graph. Response distribution of question [3-01a].

In question [3-02], the research team tried to confirm if GDOT's surveying–geomatics positions structure can be used to analyze the S-G positions distribution structure in other parts of the Southeastern United States. About 56 percent of the professionals believed that the GDOT position structure can be used to quantify the distribution of similar roles across the Southeastern U.S. About 19 percent believed the situation might differ depending on the location and the economic condition of the state. Some added that Georgia may be way ahead of some other states in terms of S-G job availability and may be underperforming when compared to some larger and economically robust states like California. About 26 percent of the professionals did not know if Georgia has enough open positions to be compared to some other states. The perceptual response is shown in figure 23.

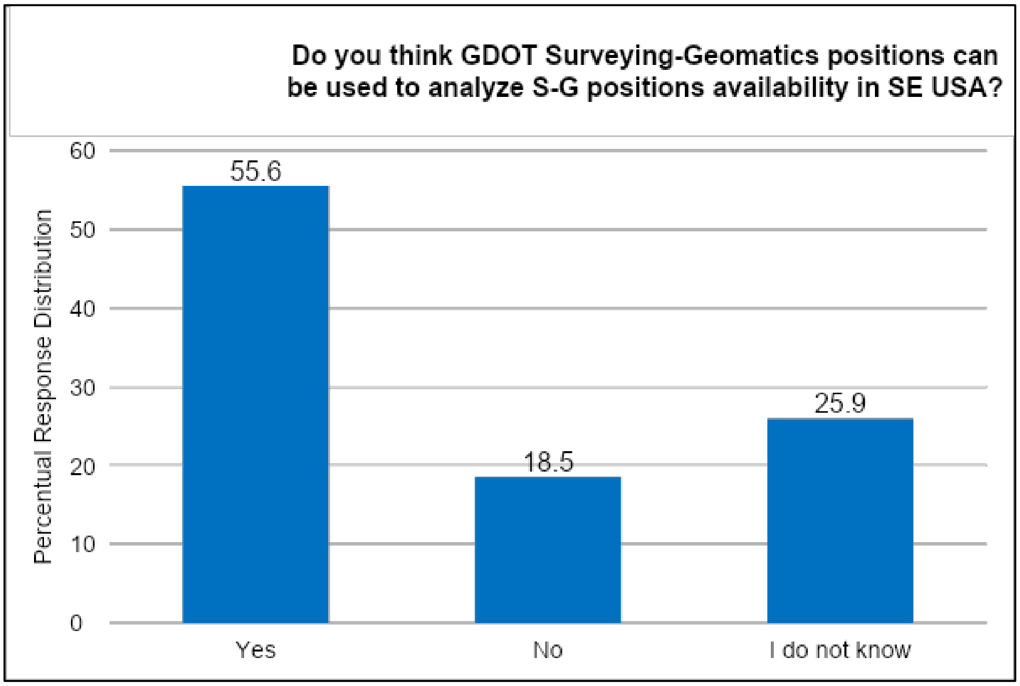


Figure 23. Bar graph. Response distribution of question [3-02].

In question [3-03], the researchers examined the correlation between the annual rates of surveying jobs that are available in relation to the number of new surveying–geomatics graduates. About 53 percent of the professionals believed the number of jobs available in both public and government institutions is adequate to take care of new graduates, 22 percent believed that the number of jobs available is not sufficient for new graduates, while 24 percent did not know about this subject. The purpose of this question was to understand the level of difficulty for new graduates in S-G to obtain a job upon graduation. Figure 24 shows the results for this question.

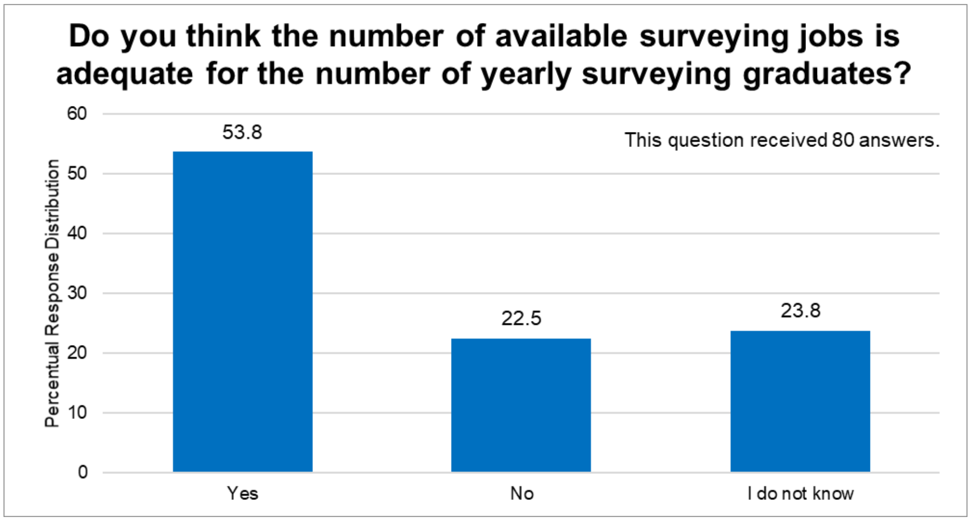


Figure 24. Bar graph. Response distribution of question [3-03].

In question [3-04], the results further emphasized the importance of having licensure as a motivation to do more on the job. Virtually all responders (84.0 percent) were in support of being a licensed land surveyor. Being a licensed surveyor has significant benefits in terms of compensation and job security, and most employers need a licensed surveyor for some roles. The results for this question are shown in figure 25.

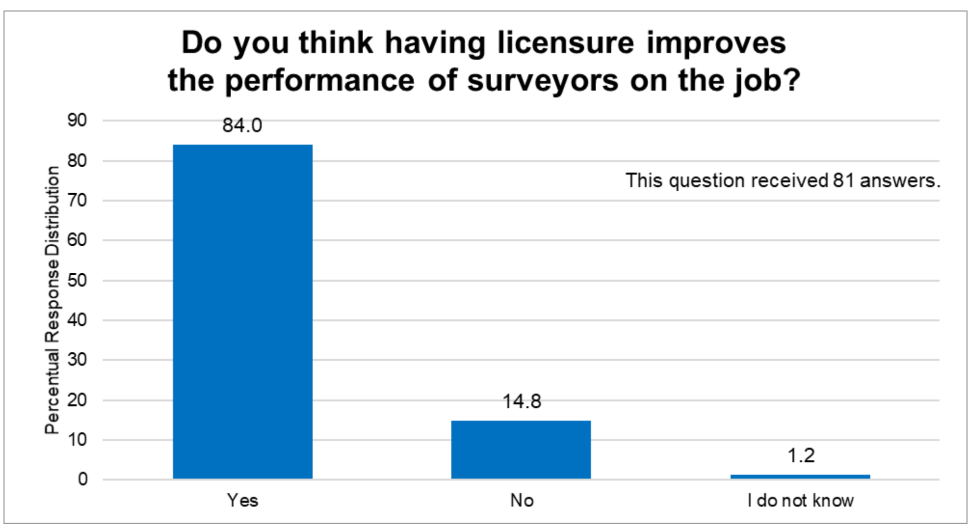


Figure 25. Bar graph. Response distribution of question [3-04].

In question [3-05], the order of importance of software/geospatial skills for S-G professionals was examined. The skills were presented in the following order:

1. GIS skills [3.05a].
2. Remote sensing skills [3.05b].
3. LiDAR tools [3.05c].
4. Other skills, including but not limited to close-range photogrammetry and GPS skills [3.05d].

The results indicated that out of a total number of 79 professional responders, 29 believed that GIS skills is the most important skill set required by most employers, 21 believed it should be the second most important and that remote sensing should be more prominent, 10 responded that LiDAR should be the third, while 19 professionals responded in favor of other geospatial skills. The results are shown in figure 26.

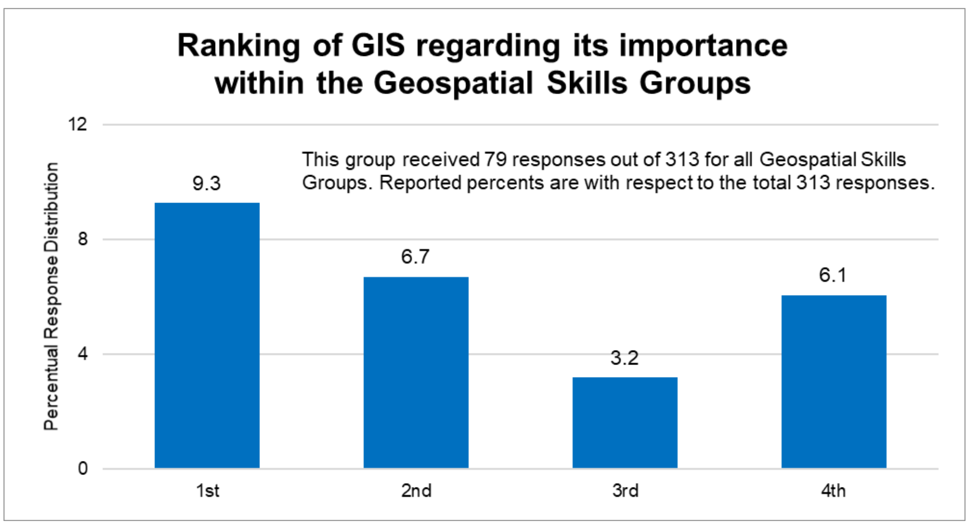


Figure 26. Bar graph. Response distribution of question [3-05a].

For remote sensing as the most prevalent geospatial skill, a total of 6 out 78 responders believed it should be given the most priority, 20 professionals thought it should be the second, 31 responders felt it should be the third most important skill, and 21 responded in favor of other skills. The results are shown in

figure 27.

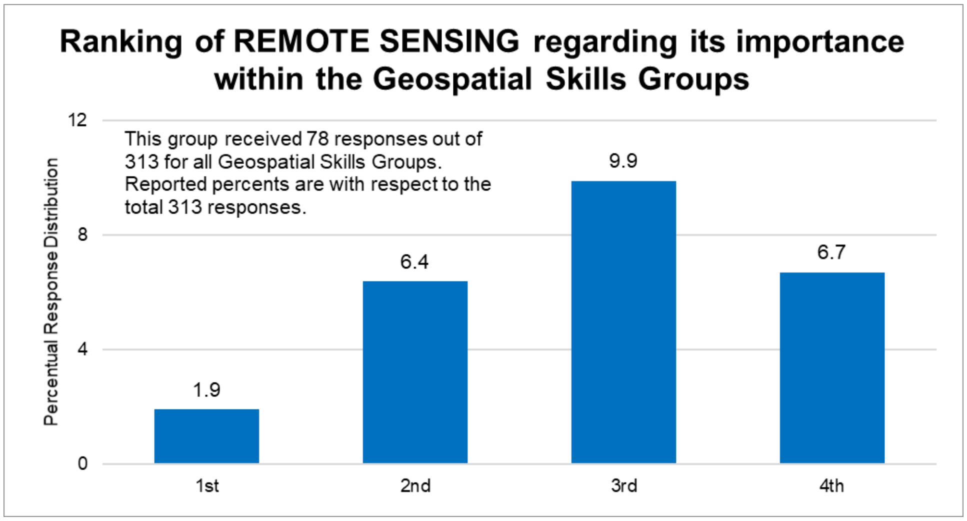


Figure 27. Bar graph. Response distribution of question [3-05b].

According to respondents, light detection and ranging usage was ranked as follows: 10 out 78 thought it should be the first priority, 31 expressed that it should be the second priority, 30 responded that it should be ranked third, while 7 thought other geospatial skills are more important than the three listed. The results of the analysis are given in figure 28.

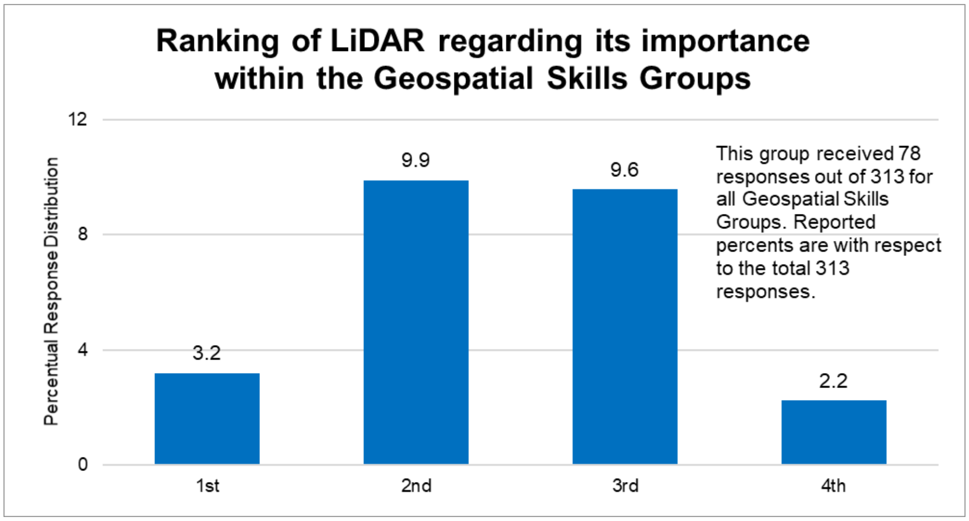


Figure 28. Bar graph. Response distribution of question [3-05c].

For other geospatial skills, such as close-range photogrammetry, cartography, GPS skills, etc., a total of 34 out of 78 responders listed various other skills as the most important. Seven respondents listed this skill group as the second most important skill, 7 listed others as the third preference, and 30 professionals had other preferences as their fourth option. Some of the responders added that they believe boundary surveying, legal aspects, field techniques, and surveying operations management should be paramount before being further exposed to the other geospatial skills. The results are shown in figure 29.

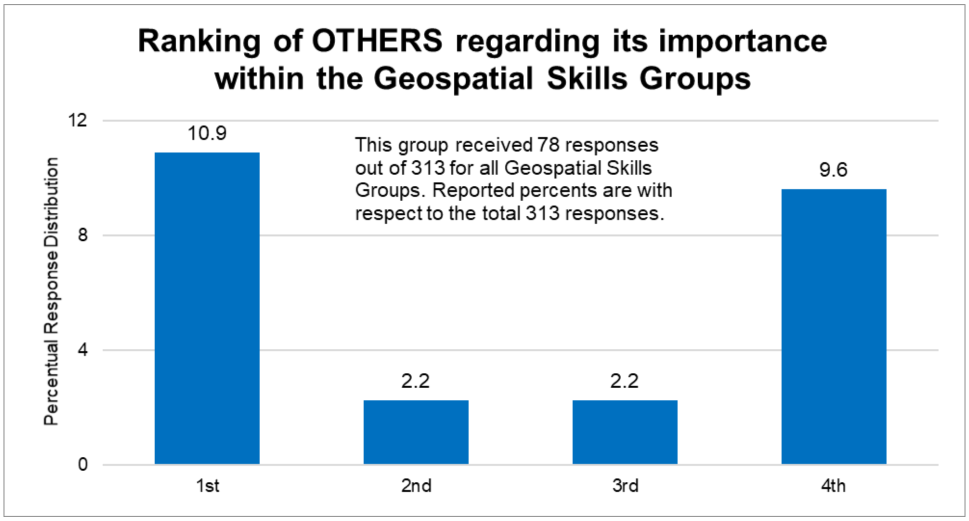


Figure 29. Bar graph. Response distribution of question [3-05d].

Having investigated the most prevalent skill set in the S-G field, it will help in broadening the S-G academic curriculum, which can concentrate more on the knowledge/skills required by the industry and prepare new S-G graduates for the industry prior to graduation.

After reviewing the most prevalent skill set in the S-G job market, it is important to rank the methods that will help strengthen the knowledge of S-G students [3.06]. In order of importance, participants were able to express how the school academic curriculum should be tailored toward preparing students for opportunities upon completion of their program. The order from the responses is provided in figure 30.

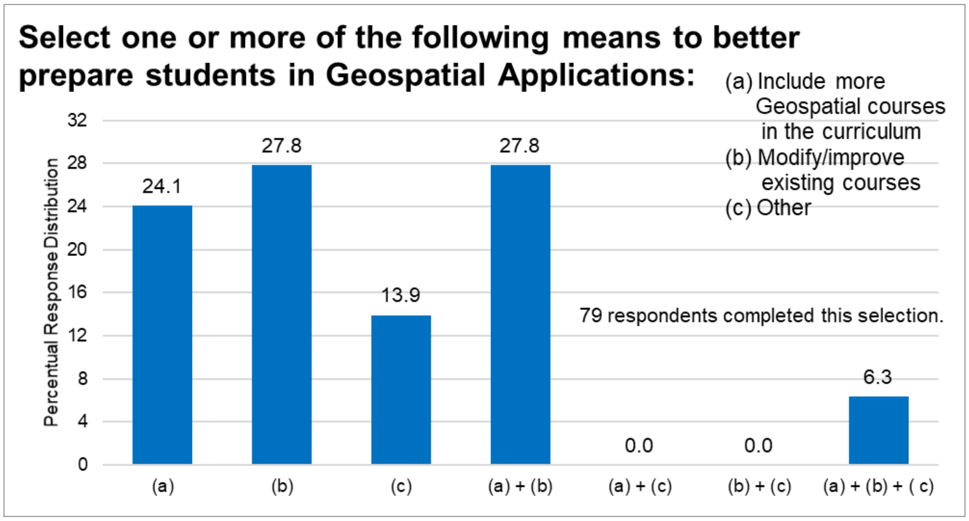


Figure 30. Bar graph. Response distribution of question [3-06a].

From the responses from professionals for question [3.06], 24.1 percent believed more geospatial courses should be added to the S-G program curriculum, 27.8 percent believed that it is better to look for ways to improve the existing courses and modify those to make them better and more detail oriented, while 13.9 percent had various other suggestions. Some added in part b that their concern was that current students in geospatial-based education may not be interested in pursuing a full-time career in S-G.

In question [3.07], the researchers investigated the work environment for entry-level S-G positions, and respondents indicated as follows: 28.0 percent strongly believed that most entry-level positions require mostly field work and that the field work decreases as they move up in rank, 39.0 percent believed that fieldwork is required for all entry-level positions, 14.6 percent disagreed, 4.9 percent strongly disagreed, and 13.4 percent were indifferent. Some of the respondents added that working in the field provides a better understanding of the workflow and data creation. The results for this question are shown in figure 31.

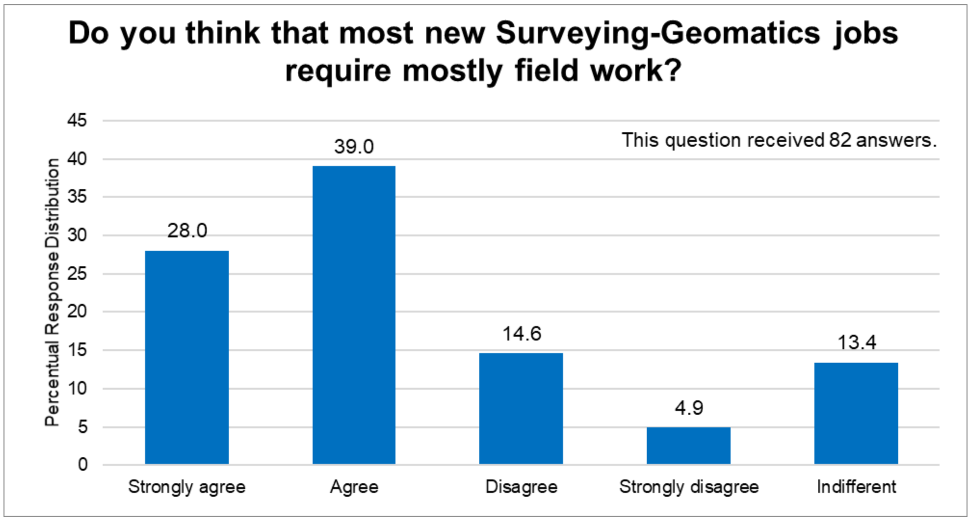


Figure 31. Bar graph. Response distribution of question [3-07a].

In question [3.08] of the survey, the research team examined whether most of the S-G employers would prefer to hire individuals with in-house experience or if they would prefer to bring in people that are not already part of the company. About 71 percent of the professionals believed people with prior experience within the same organization should know more about the work involved and should be allowed to change roles within the organization if they have demonstrated a good performance in their new department. About 16 percent believed it was better to hire new people from outside for training and invariably creating more opportunities. The results are shown in figure 32.

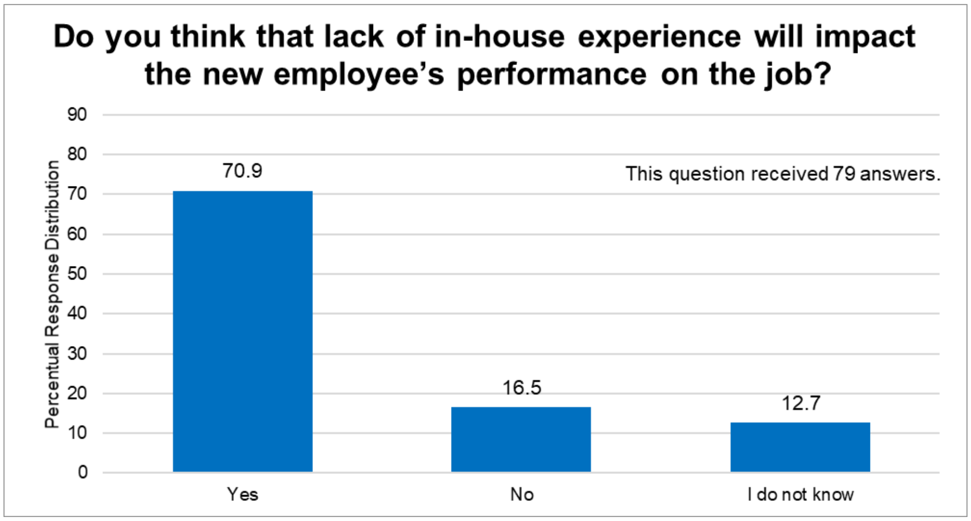


Figure 32. Bar graph. Response distribution of question [3-08].

In question [3.09], the research team examined the view of professionals regarding hiring surveyors strictly based on their years of experience. About 38 percent were of the opinion that hiring should be based on the number of years of experience, while more than 50 percent were of the opinion that it should not be based on the years of experience, as many surveyors develop more skills on the job, and about 11 percent responded that they were indifferent about it. The results are given in figure 33.

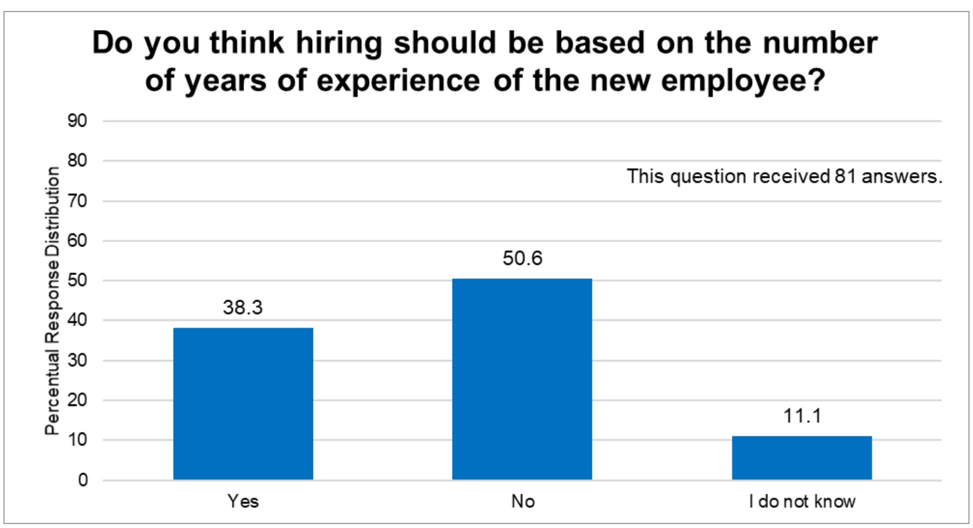


Figure 33. Bar graph. Response distribution of question [3-09].

In question [3.10], the researchers examined the respondents' point of view about S-G salaries, i.e., whether a salary range between $22,000 and $116,000 is large enough for surveyors, considering the responsibility, education, and experience requirements for modern S-G positions. About 32 percent thought the range is sufficient, 63.0 percent thought it is not sufficient, and 4.9 percent were indifferent about the salary range. The results are provided in figure 34.

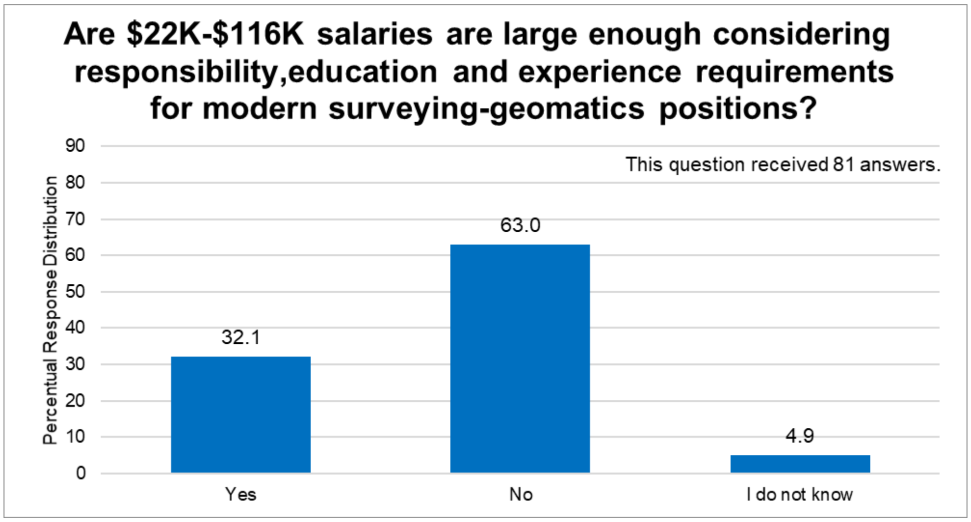


Figure 34. Bar graph. Response distribution of question [3-10].

In summary, the research team found substantial responses to support the following points:

- When surveyors are licensed, they tend to receive more benefits and, in fact, more motivation on the job. To facilitate more licensed surveyors, more pathways to licensure should be provided for surveyors while on the job.
- The bachelor's degree is the most prevalent educational requirement for most S-G positions, and most entry-level positions often require more field operation time.

- Boundary surveying, State surveying laws, and land management are viewed as important, just as geospatial skills (e.g., GIS, LiDAR, etc.) are important for all surveyors.
- Hiring of surveying personnel should not be handled by the human resources unit alone but with the help of an experienced surveying professional.
- Much more attention should be paid to the incorporation of more geospatial technologies into an S-G program curriculum.

DATA ANALYSIS: S-G EDUCATION STATUS/NEEDS

In this section, the researchers analyze the results derived from the feedback of S-G professionals from the project questionnaire survey. Nine questions had been developed, as previously discussed, to understand the existing S-G educational status and education needs of Georgia. This section considers the responses to those questions, as well as responders' comments that indicate special attention.

The feedback for question [4-01] is summarized in figure 35. The S-G professionals thought that completion of a BS in S-G–related fields is the best pathway to become a PLS (about 22 percent positive comments to support this pathway), while with specific certificate courses, they thought of it as normal practice (about 21 percent). However, 22 percent of the participants gave their opinion against the non-traditional learning method being a good way to become a PLS. Some professionals thought that traditionally the S-G profession is based on apprenticeship and that having good field experience is not replaceable with a BS degree or certificate course. Yet, they thought having a good educational background is important for a foundation and passing the PLS examination. Another argument from the respondents was that many BS-qualified graduates tend to shift their profession to civil engineering, construction management, etc., which gives them a better salary than being a PLS. Though the S-G professionals supported that having a BS degree was preferable, the number of PLS professionals is decreasing.

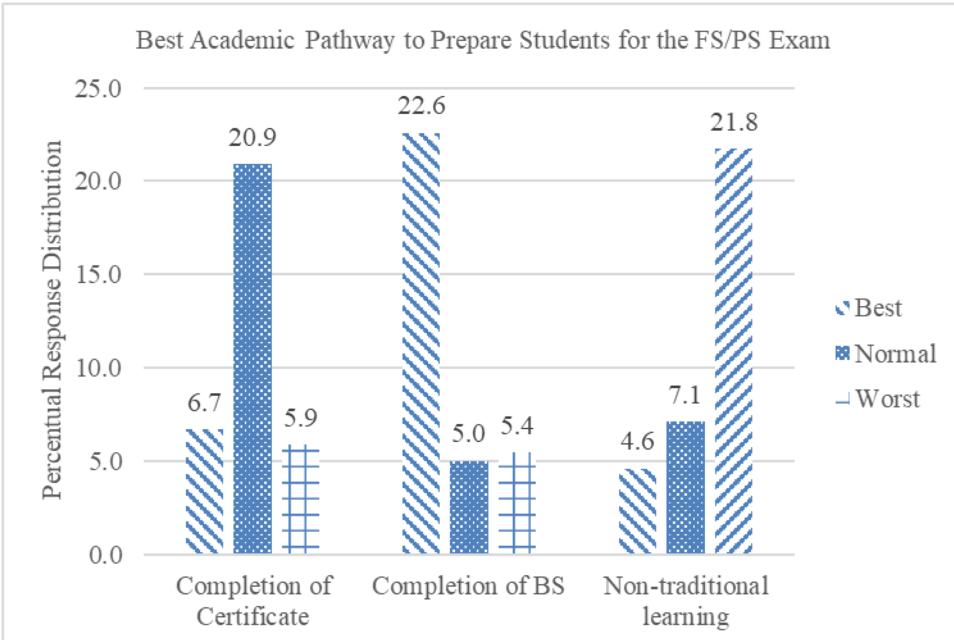


Figure 35. Bar graph. Percentual response distribution of question [4-01].

With question [4-02], the researchers were trying to understand the performance of new S-G employees based on eight parameters (figure 36): knowledge about the surveying instruments, land boundary law, professional ethics, GIS, photogrammetry, drones, LiDAR, and communication skills. These parameters were borrowed from the concept of GBORPELS-prescribed S1 to S5+ course requirements and the expected skill development. From the questionnaire survey responses, it seemed that the new employees are good at the different fundamental knowledge areas but lack in some advanced and new-technical areas. About 80 percent of the respondents thought the new employees may not be good at photogrammetry, drone, and LiDAR. This indicates that the S-G students are getting sufficient theoretical knowledge and hands-on training from the BOR-prescribed fundamental courses, such as S1 to S4. As the applicants have the flexibility in choosing the higher-level courses, as indicated in S5+, sometimes they do not get sufficient knowledge in wide technological areas. In conjunction with this, some professionals think photogrammetry, drones, and LiDAR-related knowledge are not as important as the field operation for new employees generally starting their work in the field. However, they agree that the new graduates should have the foundation of advanced S-G technical knowledge.

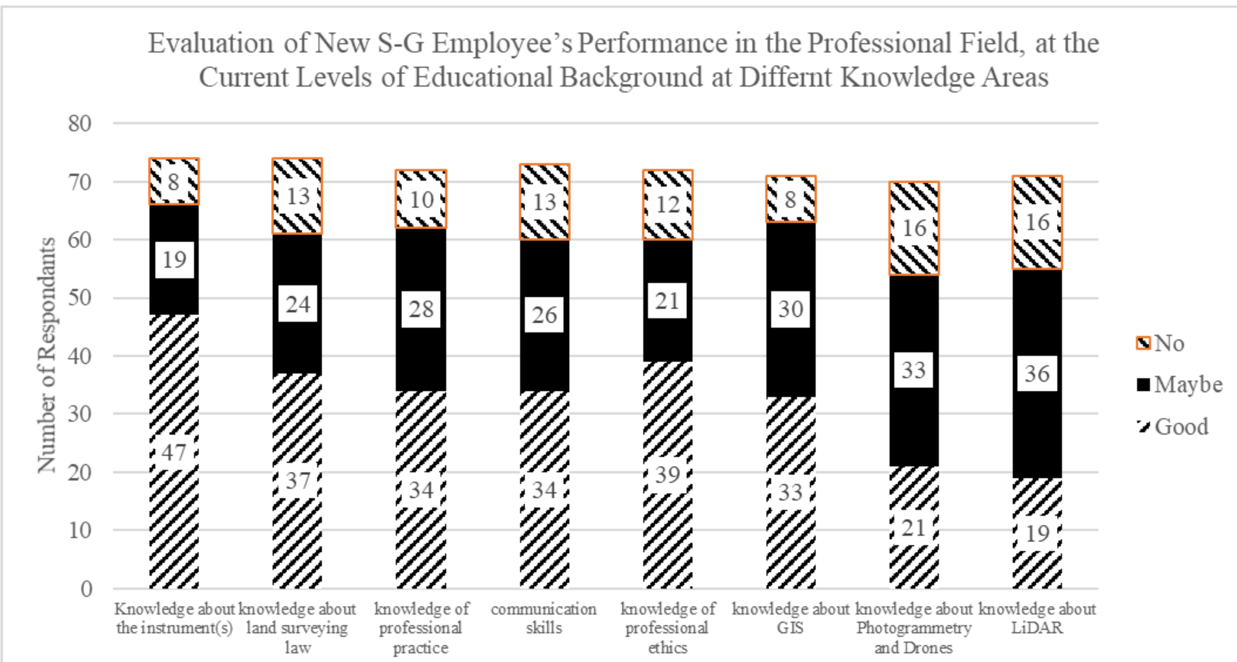


Figure 36. Stacked bar graph. Evaluation of new employee's performance based on the number of respondents' observation (for question [4-02]).

The researchers obtained a clear picture of education and skill requirements from question [4-03]. About 37 percent of the respondents thought that the Georgia BOR-prescribed S-G courses only cover the fundamental knowledge, 22 percent thought these courses support bare-minimum technologies, and 37 percent of respondents thought these courses create the background for the new technologies (figure 37). It is very clear that the S1 to S5+ courses are good for fundamentals and also create the opportunity for acquiring new knowledge in technical fields, but these are not necessarily providing a complete education. This observation also validates the response in question [4-02] that the new employees lack advanced technological knowledge in their initial stage. Some professionals thought that having only coursework will not educate a student properly, rather continuous learning will improve the understanding as well as the utilization of knowledge.

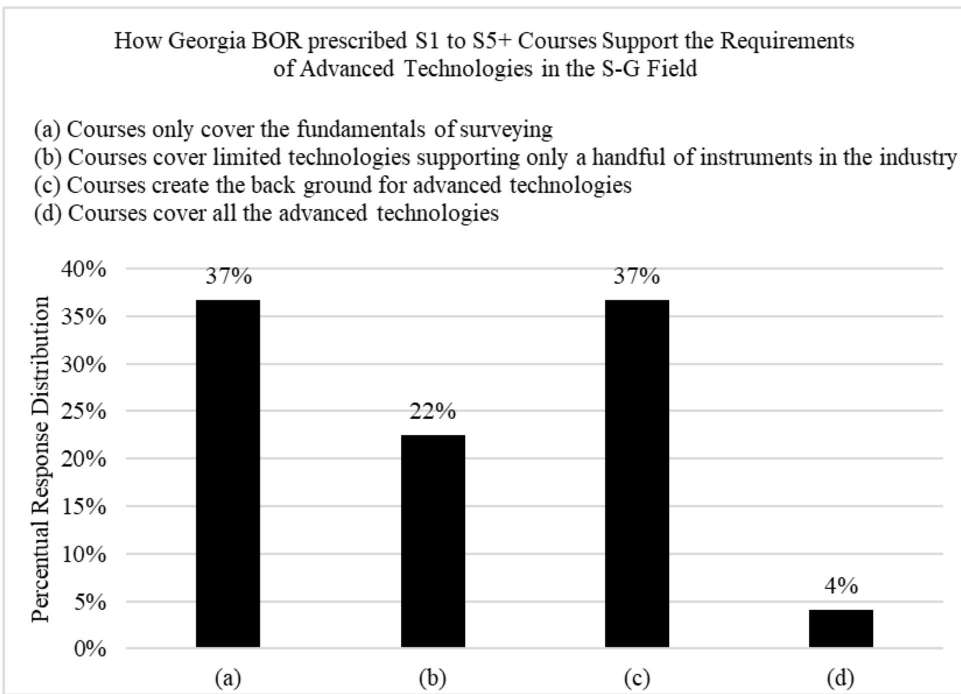


Figure 37. Bar graph. The percentual response distribution of question [4-03].

The purpose of question [4-04] was to understand the ranking of four S-G universities in Georgia based on the number of graduates they produce each year. About 68 percent of the total respondents indicated that they do not know the distribution of students in these institutes. Even though the researchers tried to understand the cluster of graduates ready to join the S-G profession with this question, the responses indicated that participants need more information/education on this topic. See figure 38 for the results.

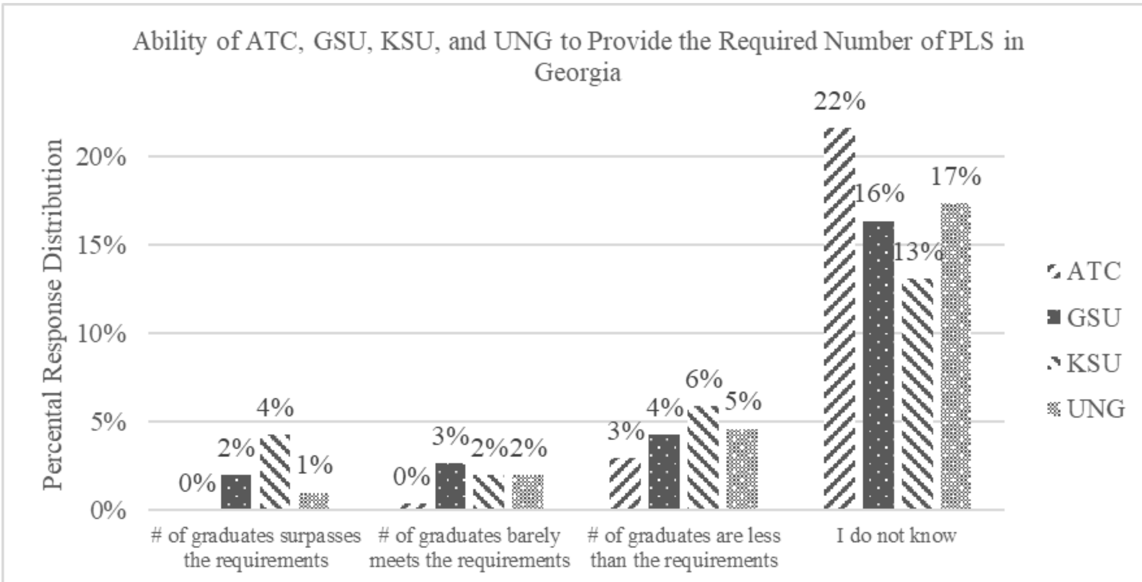


Figure 38. Bar graph. The percentual response distribution of question [4-04].

About 72 percent of respondents in question [4-05] answered that they do not know the capabilities of the four S-G colleges/universities in Georgia, as the question was based on the parameters of lab infrastructure and the professional S-G instructors (figure 39). This low response on these parameters indicated that participants need more information/education on this topic.

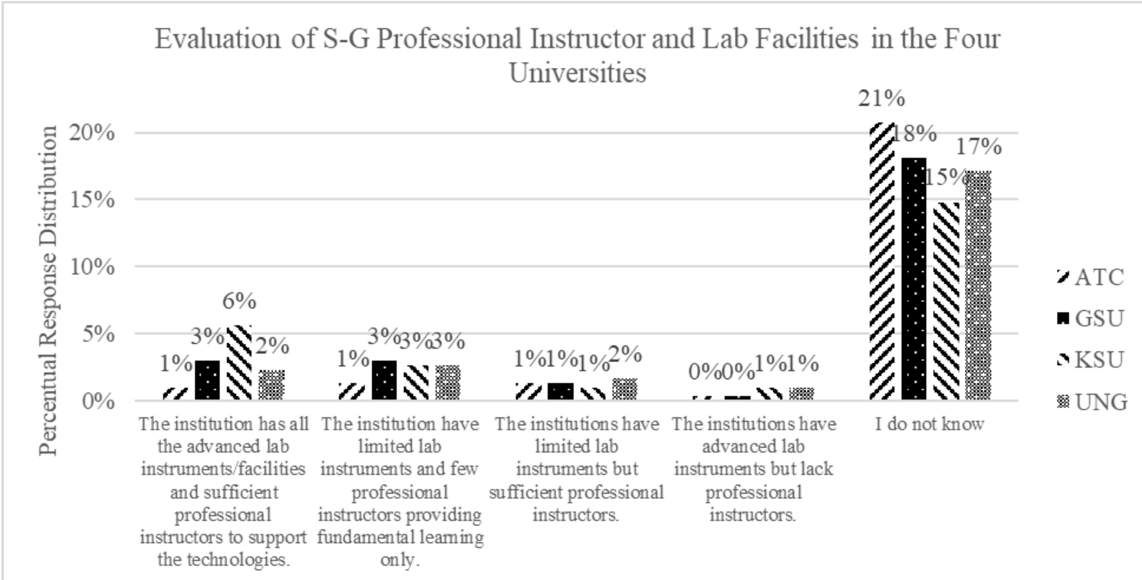


Figure 39. Bar graph. The percentual response distribution of question [4-05].

The intention of question [4-06] is to understand the quality of graduates from the four stated educational institutions. The researchers received answers from 72 percent of respondents that they do not know or cannot make an informed evaluation of the institutions (see figure 40).

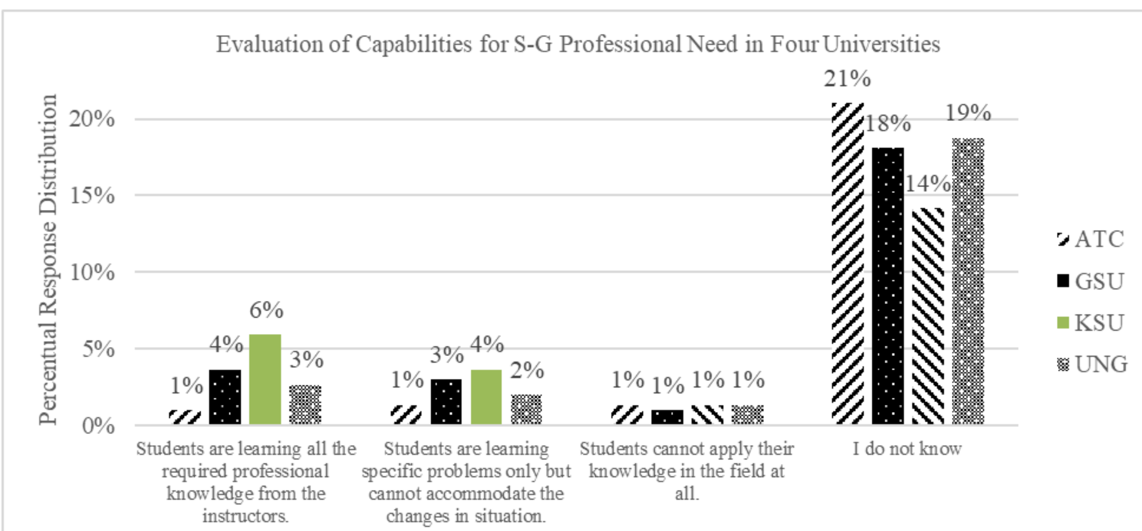


Figure 40. Bar graph. The percentual response distribution of question [4-06].

In question [4-07] the respondents indicated that the face-to-face method of class is the most popular choice for knowledge sharing and assimilation, problem-based learning, and presentation, even though it does not have time flexibility. About 38 percent of respondents believed face-to-face class is good for all aspects. At the same time, 35 percent of respondents thought the hybrid class system is also good because this method has the advantages of face-to-face with time flexibility (figure 41). Moreover, hybrid and online systems are more suitable for S-G students, especially for certificate courses and non-traditional applicants. This is logical, and the response from question [4-08] validates this observation, as about 54 percent of respondents thought the hybrid class is more suitable than the other two methods (figure 42). It is an important finding that in both cases online class seems unpopular and only a handful of S-G professionals thought of this method as effective for class. However, some professionals thought that online class is good for distant learning, though it has some limitations, such as lack of library research, students being reluctant to ask questions, and laboratory exercises being severely impacted.

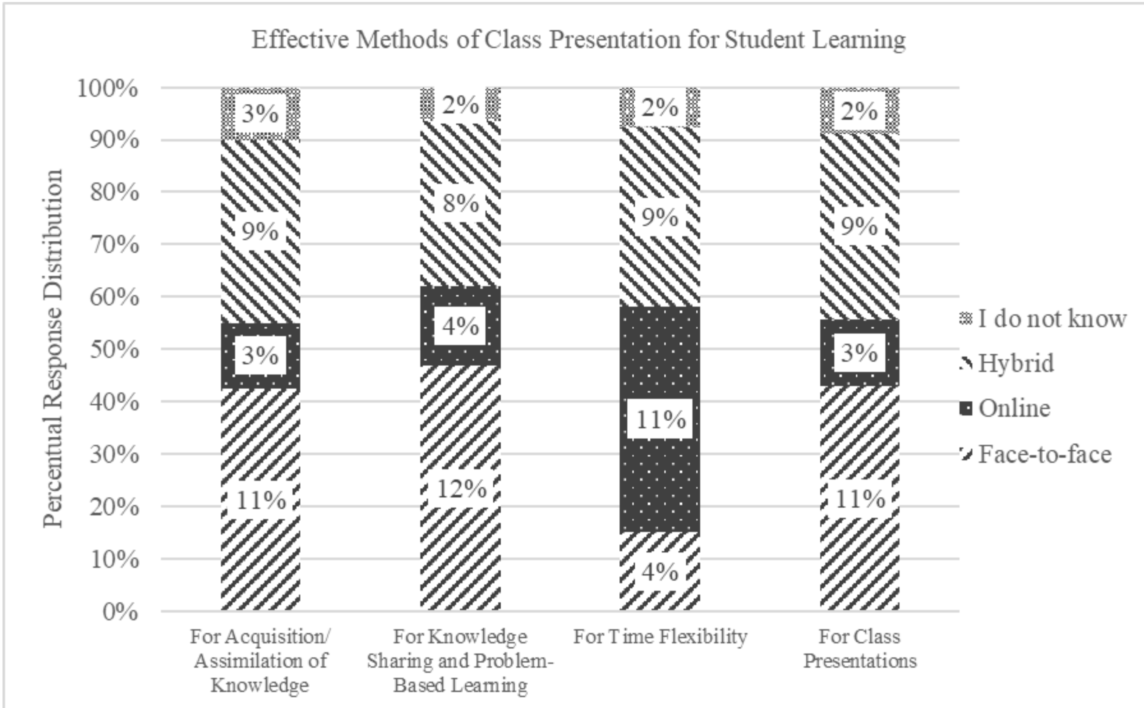


Figure 41. Stacked bar graph. The percentual response distribution of question [4-07].

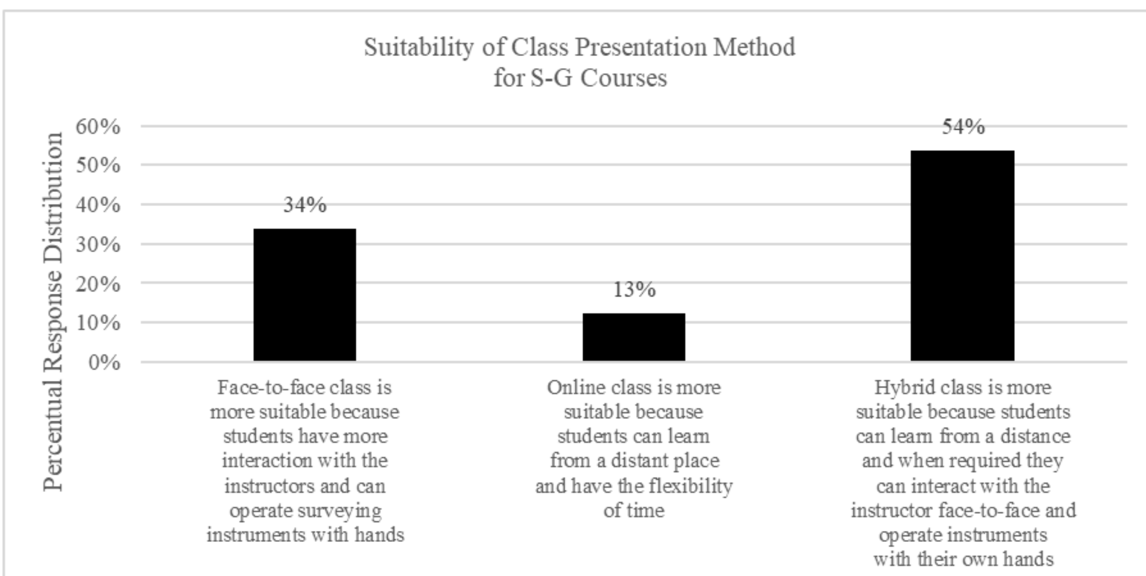


Figure 42. Bar graph. The percentual response distribution of question [4-08].

With question [4-09] the researchers were trying to understand the ranking of four universities, i.e., ATC, GSU, KSU, and UNG, based on three criteria: availability of S-G courses, overall skills in graduates, and S-G instructors who are qualified as well as experienced. The respondents gave their observations based on their perceptions. It was found that KSU came first, GSU second, UNG third, and ATC fourth in ranking based on the availability of S-G courses (figure 43). Similarly, the same sequence of ranking was observed in the case of the ‘S-G skills among the graduates’ criterion (figure 44), as well as the ‘experienced instructors’ criterion (figure 45). It is important to note that, in every case, ATC received the highest response for the fourth ranking. In this ranking process, some professionals did not participate because they felt they did not have enough information about the universities, some respondents graduated from outside the state, and some respondents thought that their ranking would be biased.

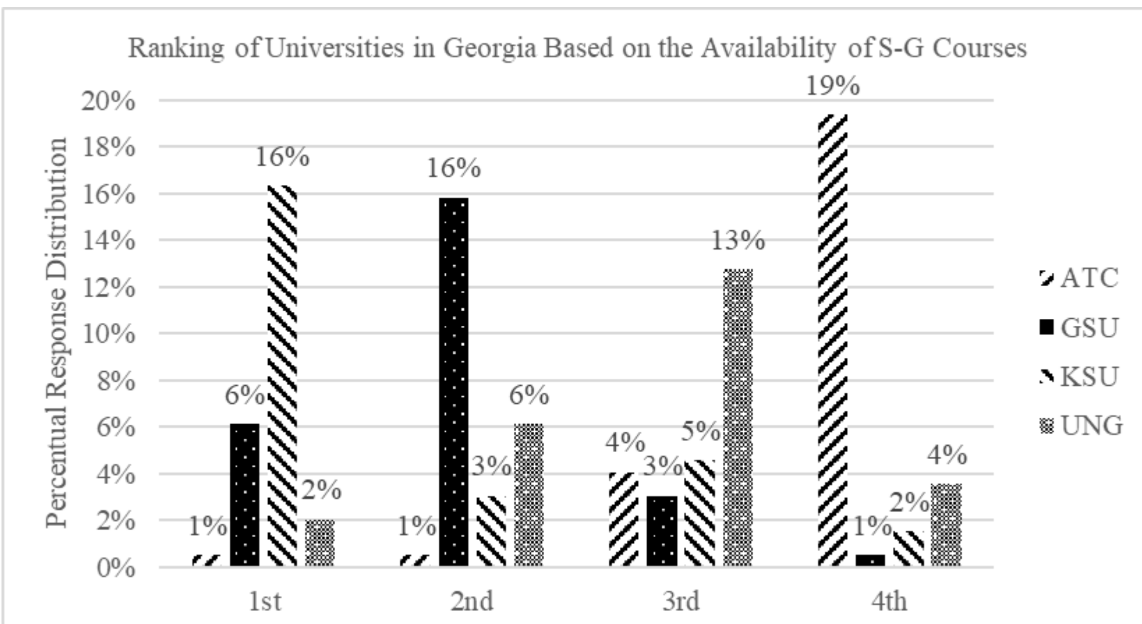


Figure 43. Bar graph. The percentual response distribution of question [4-09] for criterion 1.

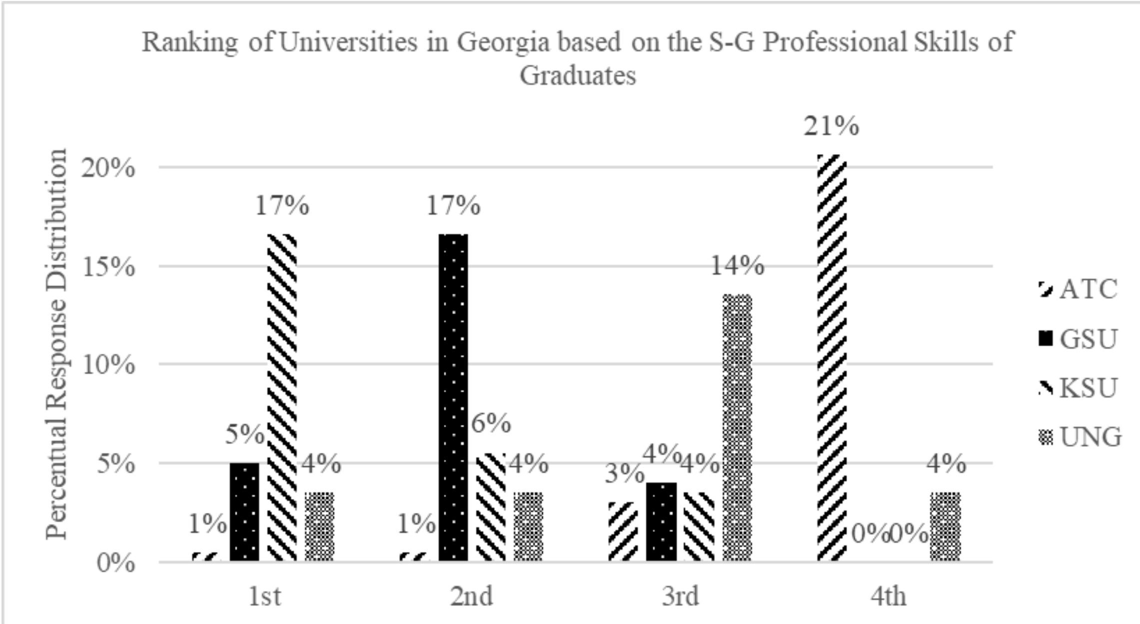


Figure 44. Bar graph. The percentual response distribution of question [4-09] for criterion 2.

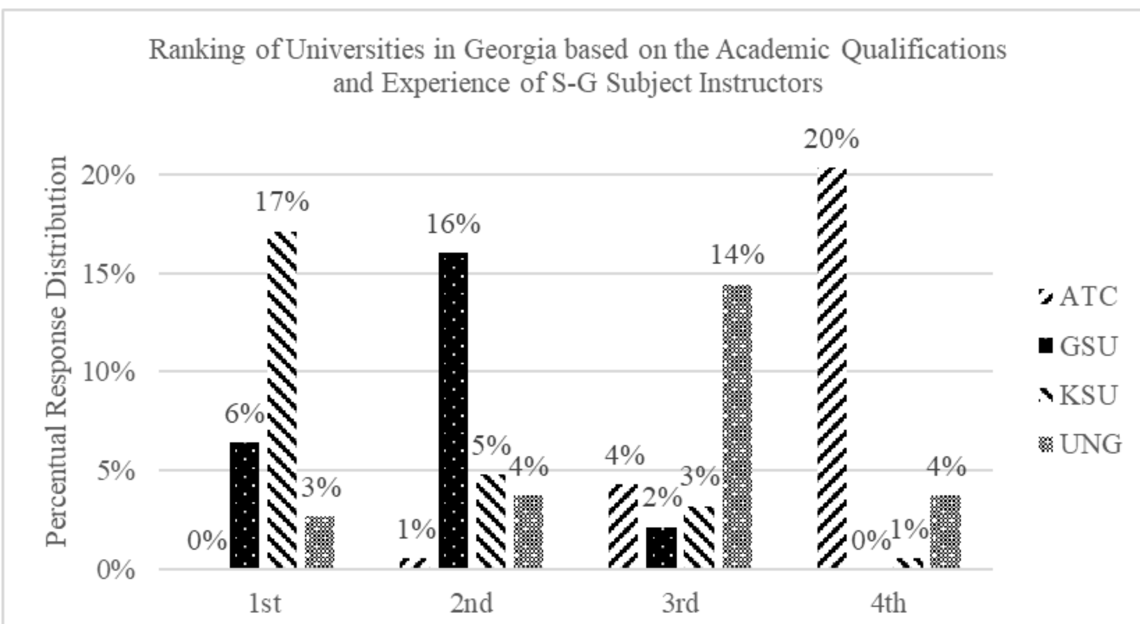


Figure 45. Bar graph. The percentual response distribution of question [4-09] for criterion 3.

The findings from the questionnaire can be summarized in the following way:

- The BS degree in an S-G–related field is the best pathway to become a PLS, and it is the most common educational background of most PLSs.
- The certificate course is considered normal practice, but the non-traditional learning method is not considered to be as good as the other two pathways.
- New S-G employees are good at the S-G fundamental knowledge areas but lack in some advanced and new-technical areas like photogrammetry, drone, and LiDAR, etc.
- The S-G professional thinks that the GBORPELS-prescribed S1 to S5+ courses are good for S-G fundamentals, as the curriculum creates a base for acquiring new techniques, but these courses are not necessarily educating for the new technologies as a whole.
- Face-to-face class is good for knowledge sharing and assimilation, problem-based learning, and presentation.
- At the same time, the hybrid class system is also acceptable, as this method has the advantages of face-to-face instruction with time flexibility and is suitable for S-G students of certificate courses and non-traditional applicants.
- The online class seems unpopular, yet a good method of presentation for distance learning.
- In terms of ranking based on the availability of S-G courses, overall skills in graduates, and qualified/experienced S-G instructors: KSU comes in first, GSU second, UNG third, and ATC fourth. This ranking is important to help understand the lack of facilities as well as the distribution of resources in different universities, which will create a path to future development in the S-G education structure in Georgia.

QUALITY OF THE SURVEYING–GEOMATICS SURVEY

In question [4-12a], the quality of this survey was ranked good by 32 out of 79 respondents (40.0 percent); also, 11 respondents (13.8 percent) answered excellent, 27 (33.8 percent) answered neutral, 9 (11.3 percent) answered poor, and 1 (1.3 percent) answered very poor. The results are shown in figure 46.

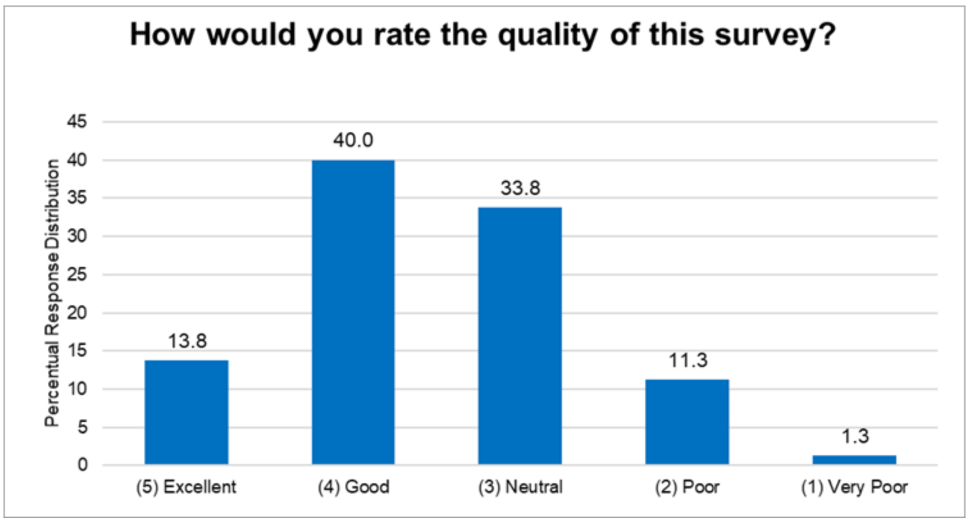


Figure 46. Bar graph. Quality of survey [4-12a].

Thus, combining the good and excellent categories gives a combined percentage of 53.8 percent, which indicates that the majority of the respondents were pleased with the survey.

In question [4-12b], the respondents' elaborations on the quality rating were as follows:

- 73 total responses.
- 29 "No comment" responses.
- 44 elaborated responses, including comments concerning:
    - Liked the survey.
    - Confusion over questions and answers.

- Survey was too long.
- Advancing education is not the answer.
- Survey was biased toward advanced S-G education.
- Lack of familiarity or background.

CHAPTER 7.
TASK 6: SURVEYING-GEOMATICS PROGRAM DEFINITION

LITERATURE REVIEW

There is a pervasive feeling that S-G education is far behind professional practice and that the gap continues to widen. Factors impacting S-G education noted by several authors worldwide include the following (Aina 2009, Aina et al. 2014, Aleem 2000, Al-Garni 2005, Hannah et al. 2009, McDougall et al. 2006, and Murray-O'Connor 2011):

- Lack of awareness and understanding of the field of geomatics.
- Weak financial support from educational authorities.
- Resistance to accept an unknown field (i.e., geomatics is relatively new).
- Misconception that geomatics is a software-based course.
- Harsh climatic conditions (very hot weather in summer and cold weather in winter).
- Expensive nature of training in geomatics.
- Few academic institutions offer courses in geomatics.
- Competition by graduates of other fields (such as geography and civil engineering).
- Lack of a regulatory body to defend geomatics practitioners.
- Difficulty recruiting and retaining highly qualified faculty.

In this study, the research team has attempted to face many of these factors head on. However, another consideration was to evaluate how students feel.

Students tend to seek out careers that bring them career gratification, but that gratification needs to come quickly according to their perception. It appears that many students are thinking about how fast they can obtain that professional certification with little focus on actual preparation for work in the profession. To counterbalance this thought, the idea of experiential learning can be applied. Thus, in experiential learning, theoretical concepts are linked with career-real activities as soon as possible (Smith 2010). Additionally, students might perceive S-G as a historically apprentice-based profession moving too slowly for their ideal progression in life. To counterbalance this perception, the S-G career path must be presented in a concise and logical way, while focusing on measurable results.

Understanding the potential S-G student more completely requires looking at some of the student's primary influencers. For traditional students, educators are now working with generations of young adults who have grown up surrounded by digital media, with most of their activities dealing with peer-to-peer communication and knowledge management mediated by these technologies (Pedro 2006). Students expect technology to be a big part of their tools for learning. Thus, the questions become: How do we incorporate as many effective student learning tools into our S-G education as possible? And how do we help the student develop critical thinking skills? Then, once the student has these skills, how do we help the student understand that life-long learning is the way to maintain those essential critical-thinking skills? These questions lead to an evaluation of the S-G program that will provide focus to the tangible elements and will help address some of these questions.

SURVEYING–GEOMATICS PROGRAM: REQUIREMENTS AND SUSTAINABILITY

A Case Study: Surveying–Geomatics at Georgia Southern University

History

The history of S-G at GSU is long-standing; the fundamental course in surveying has been taught for many years, and certainly since the ABET accreditation for the bachelor of science in civil engineering technology accreditation in 1977 (moved to ABET civil engineering accreditation in 2012). More recently, this study falls into two time periods, as follows:

- Pre-Fall 2015:
    - GSU's courses in S-G included primarily the fundamental surveying course for Civil Engineering and Construction Management with limited offerings of graduate-level courses in special topics, where technologies were applied using basic surveying equipment, i.e., transits, total stations, differential leveling equipment, and use of GPS equipment and LiDAR scanning equipment.
- Fall 2015 and following:
    - Events that influenced the increased S-G program movement at GSU include:
        - Equipment awards through grants for S-G equipment, including laser scanning and others (Dr. Gustavo Maldonado and Dr. Marcel Maghiar).
        - Dr. Roger Purcell's application of start-up research funding ($100K) primarily applied to graduate assistantships for S-G students and equipment (e.g., photogrammetry/software, scanning/geospatial support equipment, high precision leveling equipment, and machine control equipment). The GSU Civil Engineering and Construction Department Chair, Dr. Michael Jackson supported the establishment of an S-G program at GSU that would provide the education required to obtain licensure as a PLS in Georgia. Dr. Jackson's support of the S-G program began with the hiring of Dr. Purcell in the Fall of 2015.
        - Transfer of S-G equipment including terrestrial and satellite-based S-G equipment from Middle Georgia State University valued at approximately

$201K facilitated by Dr. Mohammad Davoud, Dean of the College of Engineering and Computing at GSU and Dr. Purcell. This equipment had been used in the S-G program at Middle Georgia State University up until the program was deactivated in the Spring of 2015. (S-G equipment was received by GSU in the Summer of 2017.)

- SAMSOG S-G Program Development support donations (Fall 2017, Fall 2018, and Fall 2019) totaling $75K. In Spring 2017, the SAMSOG executive board expressed concern over the potential fate of the S-G program at Kennesaw State University and confirmed support for a complete S-G program development at GSU that would provide the required education for PLS licensure in Georgia.
- GDOT Research Project Grant RP 18-10 ($99,827 awarded on 12-11-2018). This project grant has funded this report.

The S-G program at GSU that these events have shaped is ongoing in conjunction with this research. Thus, to provide a definition of the desired S-G program at GSU, the researchers developed the following criteria that the program must meet. These criteria have evolved from knowledge obtained from the literature review, from expressed desires from GDOT S-G personnel and SAMSOG, from licensure requirements at the GBORPELS, from ABET assessment criteria, from imbedded Southern Association of Colleges and Schools (SACS) accreditation criteria, and from 14 years of experience of teaching and administering an online S-G program at Middle Georgia State University.

GSU S-G Program Pathways Criteria

- Must contain the 18 semester hours of college courses as set by law and enforced by the GBORPELS through the LSIT/PLS licensure process. The structure and content of these courses must align with the S1–S5+ course structure set forth by the GBORPELS.
- Must provide course presentation platforms that accommodate S-G place-bound students and campus-based students, both traditional and non-traditional.
- Must deal with identified S-G student concerns regarding program information accessibility and program pathway definitions.
- Must provide facilities and equipment to support the required S-G program courses.
- Must provide adequate informed faculty to teach the required S-G courses.
- Must maintain an ongoing connection with GDOT and SAMSOG for the S-G program to maintain its primary goal of "Meeting the 21st Century Surveying–Geomatics Education Needs of GDOT and Georgia."

GSU S-G Program

The GSU S-G program is a program in progress that addresses the required criteria as follows:

- Developing the GSU GBORPELS S-G GSU (S1–S5+) courses: The following courses have been developed to accommodate the GBORPELS requirements. Of these courses, at the time of this writing, six of the S-series courses have been offered and the remaining courses will be offered by Fall 2021.
    - TCM 2233 Construction Surveying 3 hr (S1) (Can be cross listed with CENG 2231).
    - CENG 2231 Surveying 3 hr (S1).

- CENG 5431/G Advanced Surveying 3 hr (S2).
- CENG 5434/G Surveying History & Law 3 hr (S3).
- CENG 5438/G Surveying–Geomatics Professional Practice 3 hr (S4).
- CENG 5432/G Introduction to GIS in Surveying–Geomatics and Transportation 3 hr (S5+).
- CENG 5435/G Introduction to Terrestrial LiDAR 3 hr (S5+).
- CENG 5436/G Introduction to Close-Range Photogrammetry 3 hr (S5+).

Additional courses required for PLS candidates pursuing the storm drainage and utility design credential that goes with the PLS license:

- CENG 5137/G Engineering Hydrology and Hydraulics 3 hr
- CENG 5433/G Drainage and Erosion Control 3 hr

The course flyers, including the S-G course descriptions and the tentative course schedule for these courses can be seen at: https://cec.georgiasouthern.edu/cengc/surveying-geomatics/surveying-geomatics-course-flyers/ Also, the course flyers are provided in appendix L1 of this report.

- Course presentation platforms:
  - S-G place-bound students traditional and non-traditional: For place-bound students, the course materials (i.e., lectures, quizzes, assignments, and exams) are available on an online platform (Folio). An example of the Folio course cover page is provided in appendix L2. Four of the S-G courses include lab assignments that require supervision. For this situation, the place-bound student has the choice of using a PLS option (allowing a local professional land surveyor to serve as a

proctor-instructor for the lab assignments). Otherwise, the place-bound student would need to make arrangements to attend condensed on-campus lab sessions.

  - Campus-based students, traditional and non-traditional: For campus-based students, the course materials (i.e., lectures, quizzes, assignments, and exams) are available on an online platform (Folio). For completing labs, the campus-based student has the choice of using a PLS option or attending regular course lab sessions.

- Dealing with S-G student concerns regarding program information accessibility and program pathway definitions: Based on GSU's experience, students relate strongly to online information. Further, investigation of other successful S-G programs revealed that they were supported by comprehensive web information. Thus, for the GSU program, a comprehensive series of webpages was developed that included the following elements, which should address most of the information concerns cited in the literature review. The main button for the GSU webpage's pulldown was entitled "Surveying–Geomatics Program Pathways (New)" and can be seen at: https://cec.georgiasouthern.edu/cengc/surveying-geomatics/
  - Program Overview: The overview page contains the six S-G program pathways, which include:
    - Non-traditional path: This pathway is for working and older students and includes only prerequisite and required courses for LSIT/PLS licensure.
    - BSCE degree (civil engineering) with an S-G–embedded certificate.
    - BSConE degree (construction engineering) with an S-G–embedded certificate.

        - BSCon degree (construction management) with an S-G–embedded certificate.
        - MSCE degree (civil engineering) with an S-G–embedded certificate.
        - Accelerated bachelor’s to master’s degree in civil engineering with an S-G–embedded certificate.

All these pathways have advising sheets, which are shown in appendix L4. Snapshots of all the webpages discussed below are presented in appendix L3.

- Apply Today: This page directs the potential S-G student on where to apply to the university. Their selection is guided by the wording of the program headers.
- Career Opportunities: This page shows many of the career opportunities that are available to surveyors and includes certain career search tools that have links to guide the student in finding more information.
- Frequently Asked Questions (FAQ): The FAQ page was developed to give a potential surveying student general information on S-G as a student and as a career.
- Contact Your Future Advisor: This page gives the potential S-G student the contact information for his or her advisor based on the program pathway that they are taking.
- Instructors: The current faculty members teaching S-G courses are shown on this page with their GSU phone contact.
- Links of Interest: The Links of Interest page was created to give students as many links as possible to obtain information about S-G education and licensing.

- SAMSOG Student Chapter: The SAMSOG Student Chapter page was created to provide contact information for the newly created student chapter of SAMSOG. Being affiliated with a student SAMSOG chapter allows the student access to many S-G events, including SAMSOG's Annual Technical Seminar and the Summer Meeting at a reduced rate.
- Surveying–Geomatics Scholarships: The S-G Scholarships page was created to identify opportunities for obtaining scholarships/funding to help support the S-G student.
- Surveying–Geomatics Course Flyers/Schedule: Finally, the S-G Course Flyers page was set up with links to informational flyers for all the S-G courses offered at GSU. Also, the page includes a tentative schedule that identifies which semester the S-G courses are offered. Note: Apart from CENG 2231/TCM 2233, the courses are only offered once per year. Therefore, the S-G student needs to set up their schedule utilizing this course schedule information.

- Providing facilities and equipment to facilitate S-G program courses: Terrestrial surveying equipment that is currently in place at GSU is adequate for the SURV 2231/TCM 2233 courses. However, as students move up the course ladder, additional GPS, scanning, and other emerging technology equipment will be needed. Also, at the end of Fall 2021, having completed the offering of all the courses at least once, an assessment of the equipment will be essential. Funding for equipment is generally available at the end of the fiscal year, but the funding is always limited. Support for equipment purchases through grants, program contributions, and S-G equipment manufacturers' support will need to be pursued on an ongoing basis.

- Providing adequate informed faculty: Finding suitable S-G faculty is an ongoing and pervasive problem. Many universities only want to hire PhD-level faculty in S-G, which is virtually impossible since only two or three universities in the U.S. offer such a doctoral program. At GSU, the situation is good since four of the five faculty have PhDs, though not in S-G. However, all the PhD faculty have some experience with surveying. One faculty member has extensive professional practice (27 years) in S-G and has a Georgia PLS license, as well as a minor in geospatial science. Another faculty member has taught S-G for several years and has pursued research in emerging technologies in S-G. Also, GSU has a part-time faculty member who has a GIS Professional (GISP) certification, as well as a PE with a master's degree in civil engineering. Thus, GSU is well poised to promote this developing program.
- Maintaining an ongoing connection with GDOT and SAMSOG: To sustain the S-G program at GSU, GDOT and SAMSOG will need to be supportive of the mission by helping recruit new S-G students, by sharing expertise in emerging technologies, by funding assistance, and by supporting new S-G graduates through information about opportunities for new positions and advancements in S-G.

Program Cost

A Limited Pro-forma

To formulate the ongoing need for funds to maintain the S-G program at GSU, a look at income versus expenses was taken. For this limited examination, only a look at probable tuition/fees as income and projected salaries as expenses is possible due to the lack of available data. The examination period is one year or three semesters. The following assumptions were applied:

- A cohort of 20 new students per year was assumed.
- Twenty (20) students per year with two years on average to complete the program yields approximately 40 dedicated S-G students in place during each year.
- With 40 students taking courses at the rate of 1.5 S-G courses per semester and 3 hours per course, a yearly course demand of 180 courses or 540 semester hours was generated.

Thus, yearly income was estimated at 180 courses × $530.80/course at 3 credit hours (average of full-time and part-time student) = $ 95,544.00. Next, looking at salary/overhead expenses where the information is based on projected salaries and overhead, a calculation was made utilizing a combination of part-time and full-time teaching. For part-time faculty, the course rate was approximately $4,058.00 per course. Thus, for part-time faculty courses, the yearly expenses with four courses projected would be $4,058 × 4 = $16,232.00. For full-time faculty courses, the average course rate could be calculated as one tenth of the yearly salary plus expenses or approximately $134,707.00/10 = $13,471.00 per course. Thus, for full-time faculty courses, the yearly expenses would be $13,471.00 × 4 = $53,884.00. Therefore, combining the part-time and full-time faculty expenses totals $16,232.00 + $53,884.00 = $70,116 per year. Finally, the apparent income/expense ratio was calculated at $95,544.00/$70,116.00 = 1.4, which is much greater than a break-even number. This limited pro-forma gives hope for program sustainability. However, the need for funding beyond tuition and fees is anticipated.

Program Success Metrics

The success of the GSU S-G program requires a continuous focus with constant attention on three main areas, as follows:

- Communication with the S-G student: In addition to the communications about program pathways and curriculum, the GSU S-G student must be provided with excellent communication throughout their course interactions and through their involvement in professional-society (i.e., SAMSOG, NSPS, and NGS) activities. The GSU S-G student must be made aware of emerging technologies and changes in laws and statutes affecting S-G in Georgia.
- S-G student enrollment: S-G student enrollment must be monitored to ensure that cohort minimums are met, and that enrollment is increasing progressively. Enrollment will be a direct metric for sustainability of the S-G program.
- GSU S-G student success rate on the LSIT (FS)/PLS (PS) exams: Tracking of the S-G professional exams will be necessary to evaluate the effectiveness of the program teaching and the resulting student learning in the program courses. This information is critical and should be pursued via every available avenue, including student surveys, as necessary. According to NCEES, the U.S. nationwide passing rate of the Fundamentals of Surveying exam is 66 percent (appearing first time) and 49 percent (repeat test taker), and for the Principles and Practice of Surveying exam is 70 percent (appearing first time) and 45 percent (repeat test taker) (NCEES 2021a, 2021b). According to SAMSOG, the passing rate of PS applicants in Georgia is 66 percent for first-time test taking (SAMSOG 2020).
- GSU S-G student success in employment and advancement: The ability of GSU’s S-G program graduates to obtain entry-level positions and ultimately find meaningful careers in S-G is paramount. Student and employer surveys may be necessary to obtain this information. Also, career advancement should be tracked to the degree possible.

CHAPTER 8.
CONCLUSIONS AND RECOMMENDATIONS

VALIDATION OF THE THREE S-G MATRICES

The validation of all three of the S-G matrices—knowledge and skills, employment positions, and education/subject coverage—as provided by GDOT personnel was successful. For the knowledge and skills matrix, the five main areas, i.e., positioning, geospatial science, imaging science, land stewardship, and legal aspects, were evaluated thoroughly by GDOT and the results reflected the relative distributions of work in these areas. For the employment positions matrix, GDOT personnel's validation evaluation responses gave insight about position work location, job distribution, and required education for positions. For the education subject coverage matrix, the validation was provided in terms of GDOT's perception about S-G education enhancement opportunities/methods and GDOT's priorities toward S-G education.

Results of S-G Survey: Knowledge and Skills

The knowledge and skills survey results can break down as follows:

- For positioning with respect to the importance to S-G operation: Measurements, data analysis, and adjustments were ranked as first, second, and third, respectively. This analysis was consistent with optimizing the S-G process for creating usable surveying information, whether terrestrial or satellite-based.
- For positioning with regard to importance for new LSIT/graduate skills: Measurements, data analysis, and adjustments were ranked as first, second, and third, respectively. This analysis was consistent with optimizing the S-G process for creating usable surveying information, whether terrestrial or satellite-based.

- For geospatial science with respect to the importance to S-G operation: Geospatial data, analytical methods, and data modeling were ranked as first, second, and third, respectively. This analysis reflected how geospatial science is most practiced by the respondents. Nearly all S-G personnel have some use of geospatial data, while fewer S-G personnel might perform analytical method or data modeling.
- For geospatial science with respect to weakness ranking for new LSIT/graduate skills: Management and organizational aspects was the weakest, followed by analytical methods and then data manipulation. This ranking reflects a lack of experience for new graduates, which should change over time,
- For imaging science for significant importance for daily S-G operation, two rankings were notable, topography and digital elevation models (first) and project planning (second). It should be noted that participation was extremely low in this area, which may indicate the respondents' lack of knowledge and experience in this area.
- For imaging science with respect to weakness ranking for new LSIT/graduate skills: Project planning, mapping, and cartography and estimation, adjustments, statistics, and error propagation were notable as weakest among other subareas. However, it should be noted that participation was extremely low in this area, which may indicate the respondents' lack of knowledge and experience in this area.
- For land stewardship with respect to significant importance for daily S-G operation: Communications skills, project administration, management and organization, and site design and resource management were ranked as first, second, and third, respectively. This analysis was consistent with optimizing the S-G process for operation of an S-G business.

- For land stewardship with regard to significant importance for new LSIT/graduate skills: Communication skills, site design and resource management, and site constraints were ranked as first, second, and third, respectively. This ranking reflects a lack of experience for new graduates, which should change over time,
- For legal aspects with respect to significant importance for daily S-G operations: Law and business, legal resources, and legal systems were ranked as first, second, and third, respectively. This analysis was consistent with optimizing the S-G process for operation of an S-G business.

Results of S-G Survey: Surveying–Geomatics Positions: Employment

The S-G positions/employment survey results break down as follows:

- When surveyors are licensed, they tend to receive more salary/benefits and, in fact, more motivation on the job.
- The bachelor's degree in S-G or a related field was shown to be the most prevalent educational level for most S-G positions, and most entry-level positions often require more field operation time.
- Boundary surveying, State surveying laws, and land management are viewed as important as geospatial skills (e.g., GIS, LiDAR, etc.) for all surveyors.
- Hiring of surveying personnel should not be handled fully by the human resources unit, but include the help of an experienced surveying professional.
- More attention should be paid to the incorporation of more geospatial technologies into S-G program curriculum to support modern S-G employment.

Results of S-G Survey: Surveying–Geomatics: Subject Area/Education Status/Needs

The S-G subject area/education status/needs survey results break down as follows:

- The BS degree in S-G or a related field provides the best pathway to become a PLS and it is the most common educational background of most PLSs. However, other pathways must be available for non-traditional and/or place-bound students.
- The certificate program can be considered a normal practice, but the non-traditional learning method was not as highly ranked as the other two educational pathways.
- The evaluation shows that the new S-G employees are good at the S-G fundamental knowledge areas but lack in some advanced and enhanced-technical areas like photogrammetry, drone applications, and LiDAR, etc.
- The S-G professional thinks that the GBORPELS-prescribed S1 to S5+ courses are good for S-G fundamentals and that the curriculum creates a base for acquiring new techniques. However. this curriculum is not necessarily educating the new surveyor for the new technologies (emerging technologies) as a whole.
- Face-to-face course presentation was ranked as good for knowledge sharing and assimilation, problem-based learning, and presentation.
- The hybrid class system was also acceptable, as this method has the advantages of face-to-face instruction with time flexibility and is suitable for S-G students of certificate courses and non-traditional applicants.
- The online class seemed unpopular, yet this method represents a good method of presentation for distance learning. (i.e., for place-bound students such as GDOT employees and non-traditional students.)

- Based on the availability of S-G courses, overall skills in graduates, and qualified/experienced S-G instructors, the Georgia S-G institutions were ranked to help understand the lack of facilities, as well as the distribution of resources, in different universities. This analysis will help chart a path to future development in the S-G education structure in Georgia.

Surveying–Geomatics Program Definition

- The presentation of a GSU S-G program that meets the criteria that support S-G education for GDOT and Georgia has been developed and made available through a series of new webpages on GSU's Civil Engineering and Construction Department website. Having been modeled after another successful online S-G program, this presentation is focused on providing timely S-G education information for the prospective S-G student.
- Providing multiple S-G program pathways (i.e., non-traditional, undergraduate, and graduate) at GSU optimizes the number of future students who can take advantage of the S-G program and supports the program's sustainability.
- A look at GSU S-G equipment and faculty provided a favorable insight on the current status of terrestrial equipment for teaching. However, equipment for teaching and research with more modern equipment that utilizes emerging technologies will need to be significantly increased.
- A limited S-G program cost pro-forma indicates a positive result for income versus expenses for teaching the yearly S-G course group, assuming a yearly cohort of 20 students. It was anticipated that approximately one-half would-be place-bound students and one half would be traditional students.

Program Success Metrics

- Communication effectiveness, increased enrollment tracking, student exam (FS and PS exams) success, and student employment/career success were identified as metrics that can be used to measure the success of the S-G program at GSU. A program to set up and track these metrics will be required.

RECOMMENDATIONS

Surveying–Geomatics Survey Follow-up

As a follow-up to the S-G survey, it was anticipated that the second S-G stakeholder meeting can be held at the SAMSOG Summer Meeting during July 2021. It was further proposed that the following presentation can be covered at this Summer Meeting:

- The S-G survey results from this research will be presented in a summarized form.
- A presentation will be made to support some of the questions in the original S-G survey.
- Also, the presentation will cover the current scope of geospatial science and imaging science in the S-G environment.

S-G Program Recommendations

- It was recommended that GDOT enlist a statewide campaign, including GDOT personnel and other Georgia State government departments that perform S-G work or that procure S-G services, to inform them about available S-G education and to introduce the idea of including S-G education requirements and LSIT/PLS licensure requirements in their appropriate position descriptions.

- It was recommended that an endorsement by GDOT Commissioner McMurry be sought for S-G education requirements and LSIT/PLS licensure requirements.
- It is desired that GSU's S-G education program be made a part of the available GDOT education programs or a partner with GDOT for S-G programs in education, not just through research.
- It was recommended that S-G education/licensure be a requirement for S-G consultants utilized by GDOT, if not already in place.
- It was recommended that GDOT implement a parallel positions structure for incorporating S-G education and licensure into the GDOT S-G positions system.
- It was recommended that GDOT provide a partnership relationship in their organization chart for the GSU S-G education program.
- It was recommended that GSU investigate an educational relationship between the GSU S-G program and the appropriate Technical College System of Georgia (TCSG) colleges.
- It was recommended that ongoing financial support from equipment manufacturers and SAMSOG–Surveying and Mapping Society of Georgia, Education Foundation (SAMSEF)–GDOT should be investigated.
- It was recommended that GSU's S-G program should investigate assisting GDOT with the National Geodetic Survey's transition from the current state plane coordinate system to the new proposed International Terrestrial Reference Frames (ITRF).

Future Research Recommendations

- A data mining report should be developed from the detailed S-G survey data. This report should take the form of a research paper for the *Surveying and Geospatial Information*

Science (SaGIS) journal or the American Society of Civil Engineers (ASCE) *Journal of Surveying Engineering*.

- The application of a public–private partnership (PPP) relationship for maintaining the highest level of S-G education and S-G service for private industry and the public should be investigated.
- The best way to educate S-G personnel on the changes proposed with the NGS ITRF initiative should be investigated.

APPENDICES

APPENDIX A: INITIAL SURVEYING-GEOMATICS KNOWLEDGE/SKILLS MATRIX

A-1

Competency in Knowledge Area: Measurement	Core	Specialist	Scholar/R&D
1. Situational analysis	A	A	U
2. Technology and measurement regimen selection	A	A	U
3. Systematic error analysis	A	A	A
. Application of mathematical models for data and information representation	A	A	A
5. Designing or applying survey control	U	A	A
6. Field survey	A	A	R
Competency in Knowledge Area: Data Analysis and Management			
1. Examine data for completeness	A	A	A
. Post-processing for systematic and random error reduction and evaluation	A	A	A
3. Analyze data for precision; draw conclusions about accuracy	A	A	A
4. Determine if additional measurements are required	A	A	A
5. Integrate data from various sensors into a homogenous database	U	U	A
Competency in Knowledge Area: Adjustments			
1. Apply different adjustment procedures for data processing	A	A	A
. Apply statistical and adjustment tools to improve quality of information being reported	U	A	A
3. Calculate integrity of networks and other geometries	U	A	A
4. Apply principles of geodesy	R	A	A
Competency in Knowledge Area: Coordinate Geometry			
1. Apply two-dimensional and 3D transformations	U	A	A
2. Determine projected coordinates	U	A	A
3. Determine geodetic coordinates	R	A	A
4. Determine positions of surveyed points	A	A	A
. Determine position or configuration of designed points, lines, surfaces, and volumes	A	A	A
6. Determine areas and volumes	A	A	A
Competency in Knowledge Area: Information Extraction			
1. Report positions, lines, surfaces, and volumes	A	A	A
2. Report conclusions, deductions, and inductions	A	A	A
3. Create maps and reports that are project and “consumer-specific”	A	A	A
4. Use CAD/GIS to generate user products	A	A	A

R = recognition; U = understanding; A = ability.

A-2

GIS Knowledge	Basic	Specialist	Scholar
Area: Conceptual Foundations			
1. Philosophical and social perspective	U	U	A
2. Domains of geographic information	U	U	R
3. Elements of geographic information	A	A	A
4. Geospatial relationships	U	A	A
5. Imperfections in geographic information	U	A	A
6. The origin/history of GIS	U	U	A
Area: Data Modeling			
1. Basic storage and retrieval structure	A	A	A
2. Database management systems	U	A	A
3. Tessellation data models (e.g., raster data model)	R	U	A
4. Vector and object data models	A	A	A
5. 3D, temporal and uncertain phenomena data models	R	U	A
Area: Design Aspects			
1. The scope of GIS system design	U	A	A
2. Project definition	R	A	A
3. Resource planning	R	A	A
4. Database design	R	A	A
5. Analysis design		A	A
6. Application design		A	A
7. System implementation		A	A
Area: Geospatial Data			
1. Earth geometry	A	A	A
2. Georeferencing systems	A	A	A
3. Datums	A	A	A
4. Map projections	A	A	A
5. Land partitioning systems	A	A	A
6. Data quality	A	A	A
7. Spatial data compilation	A	A	A
8. Field data collection	A	A	A
9. Metadata, standards, and infrastructures	U	A	A
Area: Data Manipulation			
1. Representation transformation	A	A	A
2. Generalization and aggregation	U	U	A
3. Change management of geospatial data	R	A	U
Area: Analytical Methods			

1. Query operations and query languages	U	A	A
2. Geometric measures	A	A	A
3. Basic analytical operations	A	A	A
4. Basic analytical methods	U	A	A
5. Analysis of surfaces	A	A	A

R = recognition; U = understanding; A = ability.

GIS Knowledge	Basic	Specialist	Scholar
Area: Analytical Methods			
6. Spatial statistics	R	U	A
7. Geostatistics		R	A
8. Geocomputation		R	A
9. Data mining		R	A
10. Network analysis		U	A
Area: Cartography and Visualization			
1. Data considerations	U	A	A
2. Principles of map design	A	A	A
3. Graphic representation techniques	U	A	A
4. Map production	U	A	U
5. Map use and analysis	U	A	A
6. Map evaluation	U	A	A
Area: Legal and Ethical Aspects of GIS			
1. Legal aspects	A	A	U
2. Geospatial information as property	A	A	U
3. Dissemination of geospatial information	R	A	R
4. Ethical aspects of geospatial information and technology	U	A	U
5. Critical thinking about GIS		U	A
Area: Management and Organization Aspects			
1. Managing aspects	R	A	
2. Economic aspects	R	A	
3. Organizational structures and procedures	R	A	R
4. GIS workforce	R	A	
5. Institutional and inter-institutional aspects		U	
6. Coordinating organizations (national and international)		U	

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A-3

Area/Core Unit	Core	Specialist	Scholar/R&D
Knowledge Area: Communication Skills			
1. Analytical skills Situational analysis Logic Objective reasoning	A A	A A	A A
2. Oral expressive skills Clarity of expression Command of language Physical presentation Ability to adapt explanations	A U R R	A A A A	A A U U
3. Writing skills Clarity of expression Command of language Presentation skills	A U R	A A A	A A A
4. Soft or "people" skills Listening skills Negotiation skills Ability to engage in reasoned debate	U R R	A A A	U U A
Knowledge Area: Site Design and Resource Management			
1. Development design, patterns, and principles Identify of existing balance of human and environmental factors Evaluation of present and future general site context, physical relationship between site and adjacent land, human cultural data, and environmental data Familiarity with existing and evolving development patterns Incorporation of sustainability principles into site design and development	R R R R	U R U R	A A U A
2. Land use development and management programs Identification of a given site's resources Familiarity with concept of sustainability Familiarity with different approaches to preserve various resources during site development	U R R	U R R	A A A
3. Immediate and cumulative effects of site design Immediate and cumulative impacts of development on humans and nature Interdependence of humans and the natural world Limitations of design	R R U	U U U	A A A
4. Legal requirements for site development Federal laws and regulations affecting site development State laws and regulations affecting site development Local ordinances affecting site development Interrelationship of legal requirements	R/ U R/ U U R	A A A A	U U R A
Knowledge Area: Site Constraints			
1. Assess site suitability for a given plan or design Familiarity with the concept of natural and societal resources Ability to identify and objectively evaluate a specific site's resources Ability to match site resources, including location, to an appropriate design Recognition of legal guidelines and restrictions	U U R U	U U R A	A A U U

2. Balancing legal and natural land use restrictions and resource management Identification of potential specific impacts (positive and negative) from proposed development Ability to evaluate changes in natural values and human values (positive and negative) resulting from development, in relation both to the site and to the larger community	U R	U U	A A

R = recognition; U = understanding; A = ability.

Area/Core Unit	Core	Specialist	Scholar/R&D
Knowledge Area: Project Administration, Management, and Organization			
1. Project administration Contractual responsibilities Legal responsibilities Professional responsibilities	U R R	A U A	R R R
2. Project organization and supervision Estimation of time, staffing, equipment, and materials needed Project phasing and scheduling Time management Staff supervision	U R U R	A A A A	R R U R
3. Project management (technology and procedures) Principles of measurement, imaging, and positioning Assessment of a project's technical needs Assessment of project's procedural requirements, including timing Identification of strengths and weaknesses of various technical approaches in seeking the most appropriate one or combination Assessment of staffing abilities and needs	U U R R R	A A A A A	A U R A R

A-4

Imaging Knowledge	Core	Specialist	Scholar/R&D
Knowledge Area: Cameras and Photography			
Metric versus non-metric	U	U	A
Calibration	U	U	A
Camera geometry and characteristics	R	U	A
Spatial resolution	U	U	C
Knowledge Area: Radiometry, Detection, and Sensing			
Optics	R	U	A
Aperture, shutter, radiometry	R	U	A
Image motion compensation	R	U	A
Detector		U	A
Knowledge Area: Frame Geometry			
Perspective geometry or pinhole camera	U	U	A

Graphical solutions using perspective		U	A
Scale and field of view	U	U	A
Relief displacement	U	U	A
Tilt displacement	U	U	A
Interior and exterior orientation	R	U	A
Knowledge Area: Image Measurements			
Reference coordinate system	R	U	A
Systematic errors and correction	R	U	A
Knowledge Area: Stereoscopy and Parallax			
Depth perception and parallax	U	U	A
Base-height ratio and vertical exaggeration	U	U	A
Stereoscopes	U	U	A
Knowledge Area: Mathematical Modeling and Analytical Photogrammetry			
Collinearity equation	R	U	A
Coplanarity equation	R	U	A
Object space coordinate systems and transformations	A	A	A
Image resection	R	U	A
Space intersection	R	U	A
Bundle block adjustment	R	U	A
Relative and absolute orientation	R	U	A
Independent models, strip formation, and adjustment by polynomials	R	U	A
Platform and trajectory modeling	R	U	A
Knowledge Area: Computer Vision			
Homogeneous coordinates	R	U	A
Fundamental and essential matrices		U	A
Eight-point algorithm		U	A
Synthetic image generation	R	U	A

R&D = research and development; R = recognition; U = understanding; A = ability.

Imaging Knowledge	Core	Specialist	Scholar/R&D
Knowledge Area: Computer Vision			
Automation and feature extraction		U	A
Knowledge Area: Estimation, Adjustment, Statistics, and Error Propagation			
Measurement errors	A	A	A
Objective functions and adjustment	A	A	A
Functional and stochastic models	A	A	A

Least squares techniques	U	A	A
Constraints	U	A	A
Error propagation, hypothesis testing, confidence statements	A	A	A
Unified least squares	U	A	A
Sequential estimation and kalman filter	R	U	A
Robust estimation	R	U	A
Knowledge Area: Stereo Restitution			
Analytical projection	R	U	A
Digital stereo workstation	U	U	A
Pairwise rectification	R	U	A
Knowledge Area: Rectification and Resampling			
Interpolation and aggregation		U	A
Nyquist sampling theorem and aliasing		U	A
Simple rectification (tilt correction only)	U	A	A
Ortho rectification (tilt and terrain correction)	U	A	A
True orthorectification (tilt, terrain, and building correction)	U	A	A
Knowledge Area: Mapping and Cartography			
Enlargement factor versus contrast and spatial resolution		U	A
Map projections and reference coordinate systems	A	A	A
National map accuracy standards	A	A	A
National map series	A	A	A
Urban and project-oriented mapping	A	A	A
Software environments	A	A	A
Knowledge Area: Topography and Digital Elevation Modeling			
Grid/raster collection	U	A	A
Unstructured point collection	A	A	A
Triangulated irregular network processing	A	A	A
Breakline processing	A	A	A
Profiles and cross sections for road design	A	A	A
Knowledge Area: Digital Photogrammetry			
Image normalization		U	A
Image matching	R	U	A
Surface reconstruction, DEM generation	U	U	A
Automatic relative orientation		U	A

R = recognition; U = understanding; A = ability.

Imaging Knowledge	Core	Specialist	Scholar/R&D
Knowledge Area: Project Planning			
Accuracy requirements	R	U	A

Control point selection	U	A	A
GPS/INS supported imaging	R	U	A
Flightline layout	R	U	A
Knowledge Area: Close-Range Photogrammetry			
Nonmetric cameras	R	U	A
Optics selection, self-calibration	R	U	A
Fixed baseline rigs		U	A
Structured light		U	A
Knowledge Area: Satellite Photogrammetry			
Orbit mechanics		U	A
Coordinate systems	U	A	A
Time systems	U	A	A
Projection models		U	A
Ephemeris and support data	R	U	A
Knowledge Area: Remote Sensing			
Spectral coverage		U	A
Classification	R	U	A
Change detection	R	U	A
Knowledge Area: Active Sensing with Lidar			
Acquisition platforms	A	A	A
Point cloud processing	U	A	A
Feature extraction	R	U	A
Mobile versus static data acquisition	U	A	A
Standards and quality issues	A	A	A
Knowledge Area: Applications			
Mapping	A	A	A
Resource inventory	U	A	A
3D object reconstruction	U	A	A
Medical applications		U	A
GIS database population	A	A	A

R = recognition; U = understanding; A = ability.

A-5

Knowledge Area/Unit/Topic	Core	Specialist	Scholar/R&D
Knowledge Area: Legal Systems			
1. Legal methods and processes	R	U	U
2. Court systems	R	U	U
3. Civil procedure	R	U	U
4. Evidence and procedures Forms of evidence Rules of evidence	 A U	 A U	 A A
Knowledge Area: Legal Resources			
1. Legal research	A	A	A
2. Courthouse research	A	A	A
3. Statutory law	U	A	A
4. Administrative law	U	A	A
5. Judicial decisions and common law	U	A	A
6. Executive orders	R	U	A
Knowledge Area: Law and Business			
1. Writing and communication Written communication skills Oral communication skills Physical presentation skills	 A A U	 A A A	 A A U
2. Contracts Nature and types of contracts, elements of contracts Contractual obligations "Limitation of Actions" statutes Breach of contract	 R U R R	 U A A A	 A A A A
3. Torts Torts and remedies Negligence Standards of care	 R U U	 U A A	 U A A
4. Copyright law	R	U	A
5. Business formation Business entities Agency and partnership relationships Business formation	 R R R	 U U U	 R R R
6. Business management and operation Employer/employee relationships Special site requirements Record keeping Electronic and digital records Tax laws	 R U R R R	 A A A U U	 U A U U R
7. Budgeting and finance	R	A	U
8. Professionalism and ethics	U	A	A

9. Liability			
Professional liability	R	A	U
Limitations on liability	R	A	A
Standard of care	U	A	A
Certifications	U	A	A
Errors and omissions	R	R	U

R = recognition; U = understanding; A = ability.

Knowledge Area/Unit/Topic	Core	Specialist	Scholar/ R&D
Knowledge Area: Law and the Practice of Surveying			
1. The professional practice			
Licensure laws	U	A	A
Standards of practice	U	A	A
2. Land Use and land management law			
Land use and land management law	U	A	A
Environmental law	U	A	A
3. Real property law			
Estates, title, and interests in real property	R	A	A
Creation and termination of real property estates and interests	U	A	A
Deeds and descriptions	U	A	A
Conveying real property estates and interests	R	U	A
Notice	R	U	A
Easement law	U	A	A
Boundary law	A	A	A
Disputes between adjoining interest holder	U	A	A
Water law	U	A	A
4. Expert witness testimony and reports	U	A	A

R = recognition; U = understanding; A = ability.

APPENDIX B: LEVEL OF COMPETENCIES

B-1

Surveying-Geomatics Body of Knowledge Scope: Positioning				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A.) Measurement	1.) Situational analysis			
	2.) Technology and measurement regimen selection			
	3.) Systematic error analysis			
	4.) Application of mathematical models for data and information representation			
	5.) Designing of applying survey control			
	6.) Field Survey			
B.) Data Analysis and Management	1.) Examine data for completeness			
	2.) Post processing for systematic and random error reduction and evaluation			
	3.) Analyze data for precision; draw conclusions about accuracy			
	4.) Determine if additional measurements are required			
	5.) Integrate data from various sensors into a homogenous database			
C.) Adjustments	1.) Apply different procedures for data processing			
	2.) Apply statistical and adjustment tools to improve quality of information			
	3.) Calculate the integrity of networks and other geometries			
	4.) Apply principles of geodesy			
D.) Coordinate Geometry	1.) Apply two-dimensional and 3D transformations			
	2.) Determine projected coordinates			
	3.) Determine geodetic coordinates			
	4.) Determine position of surveyed points			
	5.) Determine position or configuration of designed points, lines, surfaces, and volumes			
	6.) Determine areas and volumes			
E.) Information Extraction	1.) Report positions, lines, surfaces, and volumes			
	2.) Report conclusions, deductions, and inductions			
	3.) Create maps and reports that are projected and "consumer specific"			
	4.) Use CAD to generate user products			
	5.) Use GIS to generate user products			

Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
Personnel Responsibility Level; TBD

B-2

Surveying-Geomatics Body of Knowledge Scope: Geospatial Science				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A.) Conceptual Foundations	1.) Philosophical and social perspective			
	2.) Domains of geographic information			
	3.) Elements of geographic information			
	4.) Geospatial relationships			
	5.) Imperfections in geographic data			
	6.) The origin/history of Geospatial Science			
B.) Data Modeling	1.) Basic storage and retrieval structure			
	2.) Database management systems			
	3.) Tessellation data models (e.g., raster data model)			
	4.) Vector and object models			
	5.) 3D, temporal and uncertain phenomena data models			
C.) Design Aspects	1.) The scope of GIS system design			
	2.) Project definition			
	3.) Resource planning			
	4.) Database design			
	5.) Analysis design			
	6.) Application design			
	7.) System implementation			
D.) Geospatial Data	1.) Earth Geometry			
	2.) Georeferencing systems			
	3.) Datums			
	4.) Map projections			
	5.) Land partitioning systems			
	6.) Data quality			
	7.) Spatial data compilation			
	8.) Field data collection			
	9.) Metadata, standards, and infrastructures			
E.) Data Manipulation	1.) Representation transformation			
	2.) Generalization and aggregation			
	3.) Change management of geospatial data			
F.) Analytical Methods	1.) Query operations and query operations			
	2.) Geometric measures			
	3.) Basic analytical operations			
	4.) Basic analytical methods			
	5.) Analysis of surfaces			
	6.) Spatial statistics			
	7.) Geostatistics			
	8.) Geocomputations			
	9.) Data mining			
	10.) Network analysis			
G.) Cartography and Visualizations	1.) Data Considerations			
	2.) Principles of map design			
	3.) Graphic representation techniques			
	4.) Map production			
	5.) Map use and analysis			
	6.) Map evaluation			
H.) Legal and Ethical Aspects of GIS	1.) Legal aspects			
	2.) Geospatial information as property			
	3.) Dissemination of geospatial information			
	4.) Ethical aspects of geospatial information and technology			
	5.) Critical thinking about GIS			
I.) Management and Organization Aspects	1.) Managing aspects			
	2.) Economic aspects			
	3.) Organizational structures and procedures			
	4.) GIS workforce			
	5.) Institutional and inter-institutional aspects			
	6.) Coordinating organizations (national and international)			

Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
Personnel Responsibility Level; TBD

B-3

Surveying-Geomatics Body of Knowledge Scope: Imaging Science				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A.) Cameras and Photography	1.) Metric versus and non-metric			
	2.) Calibration			
	3.) Camera geometry and characteristics			
	4.) Spatial resolution			
B.) Radiometry, Detection, and Sensing	1.) Optics			
	2.) Aperature, shutter, radiometry			
	3.) Image motion compensation			
	Detector			
C.) Frame Geometry	1.) Perspective geometry or pinhole camera			
	2.) Graphical solutions using perspective			
	3.) Scale and field of view			
	4.) Relief displacement			
	5.) Tilt displacement			
	6.) Interior and exterior orientation			
D.) Imaging Measurements	1.) Reference coordinate system			
	2.) Systematic errors and correction			
E.) Stereoscopy and Parallax	1.) Depth perception and parallax			
	2.) Base-height ratio and vertical exaggeration			
	3.) Stereoscopes			
F.) Mathematical Modeling and Analytical Photogrammetry	1.) Collinearity equation			
	2.) Coplanitary equation			
	3.) Object space coordinate systems and transformations			
	4.) Image resection			
	5.) Space intersection			
	6.) Bundle block adjustment			
	7.) Relative and absolute orientation			
	8.) Independent models, strip information, and adjustment by polynomials			
	9.) Platform and trajectory modeling			
G.) Computer Vision	1.) Homogeneous coordinates			
	2.) Fundamental and essential matrices			
	3.) Eight point algorithm			
	4.) Synthetic image generation			
	5.) Automation and feature extraction			
H.) Estimation, Adjustment, Statistics, and Error Propagation	1.) Measurement errors			
	2.) Objective functions and adjustments			
	3.) Functional and stochastic models			
	4.) Least squares techniques			
	5.) Constraints			
	6.) Error propagation, hypothesis testing, confidence statements			
	7.) Unified least squares			
	8.) Sequential estimation and kalman filter			
	9.) Robust estimation			
I.) Stereo Restitution	1.) Analytical projection			
	2.) Digital stereo workstation			
	3.) Pairwise rectification			

J.) Rectification and Resampling	1.) Interpolation and aggregation			
	2.) Nyquist sampling theorem and aliasing			
	3.) Simple rectification (tilt correction only)			
	4.) Ortho rectification (tilt and terrain correction)			
	5.) True orthorectification (tilt, terrain, and building correction)			
K.) Mapping and Cartography	1.) Enlargement factor versus contrast and spatial resolution			
	2.) Map projections and reference coordinate systems			
	3.) National map accuracy standards			
	4.) National map series			
	5.) Urban and project oriented mapping			
	6.) Software environments			
L.) Topography and Digital Elevation Modeling	1.) Grid/raster collection			
	2.) Unstructured point collection			
	3.) Triangular irregular network processing			
	4.) Breakline processing			
	5.) Profiles and cross sections for road design			
M.) Digital Photogrammetry	1.) Image normalization			
	2.) Image matching			
	3.) Surface reconstruction, DEM generation			
	4.) Automatic relative orientation			
N.) Project Planning	1.) Accuracy requirements			
	2.) Control point selection			
	3.) GPS/INS supported imaging			
	4.) Flightline layout			
O.) Close-Range Photogrammetry	1.) Nonmetric cameras			
	2.) Optics selection, self-calibration			
	3.) Fixed baseline rigs			
	4.) Structured light			
P.) Satellite Photogrammetry	1.) Orbit mechanics			
	2.) Coordinate systems			
	3.) Time systems			
	4.) Projection models			
	5.) Ephemeris and support data			
Q.) Remote Sensing	1.) Spectral coverage			
	2.) Classification			
	3.) Change detection			
R.) Active Sensing with LiDAR	1.) Acquisition platforms			
	2.) Point cloud processing			
	3.) Feature extraction			
	4.) Mobile versus static data acquisition			
	5.) Standards and quality issues			
S.) Applications	1.) Mapping			
	2.) Resource inventory			
	3.) 3D object reconstruction			
	4.) Medical application			
	5.) GIS database population			

Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or ne

Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)

Personnel Responsibility Level; TBD

B-4

Surveying-Geomatics Body of Knowledge Scope: Land Stewardhip				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A.) Communication Skills	1.) Situational analysis			
	2.) Objective reasoning			
	3.) Clarity of expression			
	4.) Command of language			
	5.) Physical presentation			
	6.) Adaption of explanations			
	7.) Listening skills			
	8.) Negotiating skills			
	9.) Ability to debate			
	10.) Logic			
B.) Site Design and Resource Management	1.) Identify existing balance of human and environment factors			
	2.) Evaluate and present current and future site context			
	3.) Awareness of existing and and evolving development patterns			
	4.) Ability to incorporate principles of sustainability to site design and development			
	5.) Identification of site resources			
	6.) Federal laws and regulations affecting site development			
	7.) Local ordinances affecting site development			
	8.) Interrelationship of legal requirements			
C.) Site Constraints	1.) Assess site suitability relative to a given plan or design			
	2.) Identification of specific impacts (positive and negative) from proposed development			
D.) Project Administration, Management, and Organization	1.) Contractual responsibilities			
	2.)Legal responsibilities			
	3.) Professional responsibilities			
	4. Estimation of time, staffing, equipment, and material requirements			
	5.) Apply principles of time and staff management			
	6.) Apply principles of measurement, imaging, and positioning			
	7.) Assess a project by technical, procedural, and timing requirements			
	8.) Assess staffing abilties and needs			

Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
Personnel Responsibility Level; TBD

B-5

Surveying-Geomatics Body of Knowledge Scope: Legal Aspects				
Knowledge Area	**Associated Task**	**Priority**	**Frequency**	**Personnel Responsibility Level**
A.) Legal Systems	1.) Legal methods and processes			
	2.) Court systems			
	3.) Civil procedures			
	4.) Evidence and procedures (forms and rules) of evidence			
B.) Legal Resources	1.) Legal research			
	2.) Courthouse research			
	3.) Statutory law			
	4.) Administrative law			
	5.) Judicial decisions and common law			
	6.) Executive orders			
B.) Law and Business	1.) Written, oral, and physical presentation and communication skills			
	2.) Understanding of the nature, types, elements, and obligations of contracts (including limitations and breach of contract)			
	3.) Understanding of torts, negligence, and standards of care			
	4.) Copyright law			
	5.) Business entities and agency and partnership relationships			
	6.) Digital and electronic record keeping			
	7.) Liability, errors, and omissions			
	8.) Professionalism, ethics, and supporting certifications and licensures			

Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
Personnel Responsibility Level; TBD

APPENDIX C: PERSONNEL RESPONSIBILITY LEVELS AND RANKING

C-1

Surveying-Geomatics Body of Knowledge Scope: Positioning				
Knowledge Area	Associated Task	GDOT Priority	GDOT Frequency	GDOT Personnel Responsibility Level
A.) Measurement	1.) Situational analysis	5	4	ASPC and above
	2.) Technology and measurement regimen selection	5	4	ASPC and above
	3.) Systematic error analysis	5	3	ASPC and above
	4.) Application of mathematical models for data and information representation	5	3	ASPC and above
	5.) Designing of applying survey control	5	4	ASPC and above
	6.) Field Survey	5	5	ST AND ABOVE
B.) Data Analysis and Management	1.) Examine data for completeness	5	5	ASPC and above
	2.) Post processing for systematic and random error reduction and evaluation	5	3	ASPC and above
	3.) Analyze data for precision; draw conclusions about accuracy	5	3	ASPC and above
	4.) Determine if additional measurements are required	5	4	ASPC and above
	5.) Integrate data from various sensors into a homogenous database	5	3	ASPC and above
C.) Adjustments	1.) Apply different procedures for data processing	4	1	ASPC and above
	2.) Apply statistical and adjustment tools to improve quality of information	5	3	ASPC and above
	3.) Calculate the integrity of networks and other geometries	5	3	ASPC and above
	4.) Apply principles of geodesy	5	3	ASPC and above
D.) Coordinate Geometry	1.) Apply two-dimensional and 3D transformations	4	3	ASPC and above
	2.) Determine projected coordinates	5	4	ASPC and above
	3.) Determine geodetic coordinates	5	4	ASPC and above
	4.) Determine position of surveyed points	5	5	ASPC and above
	5.) Determine position or configuration of designed points, lines, surfaces, and volumes	5	5	ASPC and above
	6.) Determine areas and volumes	4	3	ASPC and above
E.) Information Extraction	1.) Report positions, lines, surfaces, and volumes	5	3	ASPC and above
	2.) Report conclusions, deductions, and inductions	4	3	ASPC and above
	3.) Create maps and reports that are projected and "consumer specific"	5	4	SPC and above
	4.) Use CAD to generate user products	5	5	ASPC and above
	5.) Use GIS to generate user products	5	4	

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
GDOT Personnel Responsibility Level; TBD

Knowledge Area	GDOT Priority - TP	GDOT Priority - AP	GDOT Frequency -TP	GDOT Frequency - AP
A.) Measurement	30	5.00	23	3.83
B.) Data Analysis and Management	25	5.00	18	3.60
C.) Adjustments	19	4.75	10	2.50
D.) Coordinate Geometry	28	4.67	24	4.00
E.) Information Extraction	24	4.80	19	3.80
TOTAL	126	4.84	94.00	3.55

C-2

Surveying-Geomatics Body of Knowledge Scope: Geospatial Science				
Knowledge Area	Associated Task	GDOT Priority	GDOT Frequency	GDOT Personnel Responsibility Level
A.) Conceptual Foundations	1.) Philosophical and social perspective	2	1	ALL
	2.) Domains of geographic information	2	0	LBC
	3.) Elements of geographic information	2	0	LBC
	4.) Geospatial relationships	3	2	SPCAND ABOVE
	5.) Imperfections in geographic data	3	4	SPCAND ABOVE
	6.) The origin/history of Geospatial Science	1	1	ASPCAND ABOVE
B.) Data Modeling	1.) Basic storage and retrieval structure	5	5	ST AND ABOVE
	2.) Database management systems	5	5	ASPCAND ABOVE
	3.) Tessellation data models (e.g., raster data model)	3	1	ASPCAND PHOTO TEC 2 AND ABOVE
	4.) Vector and object models	1	1	ASPCAND ABOVE
	5.) 3D, temporal and uncertain phenomena data models	3	2	ASPCAND ABOVE
C.) Design Aspects	1.) The scope of GIS system design	1	1	ASPCAND ABOVE
	2.) Project definition	1	1	ASPCAND ABOVE
	3.) Resource planning	3	4	ASPCAND ABOVE
	4.) Database design	1	1	ASPCAND ABOVE
	5.) Analysis design	0	0	ASPCAND ABOVE
	6.) Application design	0	0	ASPCAND ABOVE
	7.) System implementation	0	0	ASPCAND ABOVE
D.) Geospatial Data	1.) Earth Geometry	3	3	ASPCAND ABOVE
	2.) Georeferencing systems	4	4	ASPCAND ABOVE
	3.) Datums	4	4	ASPCAND ABOVE
	4.) Map projections	4	4	ASPCAND ABOVE
	5.) Land partitioning systems	4	3	ASPCAND ABOVE
	6.) Data quality	5	5	ASPCAND ABOVE
	7.) Spatial data compilation	4	4	ASPCAND ABOVE
	8.) Field data collection	5	5	ST AND ABOVE
	9.) Metadata, standards, and infrastructures	1	1	ASPCAND ABOVE
E.) Data Manipulation	1.) Representation transformation	4	4	ASPCAND ABOVE
	2.) Generalization and aggregation	3	3	ASPCAND ABOVE
	3.) Change management of geospatial data	3	2	ASPCAND ABOVE
F.) Analytical Methods	1.) Query operations and query operations	1	1	SPCAND ABOVE
	2.) Geometric measures	5	5	ASPCAND ABOVE
	3.) Basic analytical operations	5	5	ASPCAND ABOVE
	4.) Basic analytical methods	5	5	ASPCAND ABOVE
	5.) Analysis of surfaces	5	5	ASPCAND ABOVE
	6.) Spatial statistics	5	3	SPCAND ABOVE
	7.) Geostatistics	4	3	SPCAND ABOVE
	8.) Geocomputations	4	2	SPCAND ABOVE
	9.) Data mining	4	2	SPCAND ABOVE
	10.) Network analysis	4	3	SPCAND ABOVE
G.) Cartography and Visualizations	1.) Data Considerations	3	2	SPCAND ABOVE
	2.) Principles of map design	4	4	MAP SECTION
	3.) Graphic representation techniques	5	5	SDS+MAP
	4.) Map production	5	5	ASPCAND ABOVE
	5.) Map use and analysis	4	2	ASPCAND ABOVE
	6.) Map evaluation	4	4	ASPCAND ABOVE
H.) Legal and Ethical Aspects of GIS	1.) Legal aspects	4	2	ASPCAND ABOVE
	2.) Geospatial information as property	4	2	SPCAND ABOVE
	3.) Dissemination of geospatial information	4	2	SPCAND ABOVE
	4.) Ethical aspects of geospatial information and technology	4	2	SPCAND ABOVE
	5.) Critical thinking about GIS	4	2	SPCAND ABOVE
I.) Management and Organization Aspects	1.) Managing aspects	5	5	SCE AND ABOVE
	2.) Economic aspects	5	5	SCE AND ABOVE
	3.) Organizational structures and procedures	5	3	SCE AND ABOVE
	4.) GIS workforce	4	4	SCE AND ABOVE
	5.) Institutional and inter-institutional aspects	3	3	SCE AND ABOVE
	6.) Coordinating organizations (national and international)	3	2	SCE AND ABOVE

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
GDOT Personnel Responsibility Level; TBD

Knowledge Area	GDOT Priority - TP	GDOT Priority - AP	GDOT Frequency -TP	GDOT Frequency - AP
A.) Conceptual Foundations	13	2.17	8	1.33
B.) Data Modeling	17	3.40	14	2.50
C.) Design Aspects	6	0.86	7	1.00
D.) Geospatial Data	34	3.78	33	4.00
E.) Data Manipulation	10	3.33	9	3.00
F.) Analytical Methods	42	4.20	34	3.40
G.) Cartography and Visualizations	25	4.17	22	3.67
H.) Legal and Ethical Aspects of GIS	20	4.00	10	2.00
I.) Management and Organization Aspects	25	4.17	22	3.67
TOTAL	70	2.55	62.00	2.21

C-3

Surveying-Geomatics Body of Knowledge Scope: Imaging Science				
Knowledge Area	Associated Task	GDOT Priority	GDOT Frequency	GDOT Personnel Responsibility Level
A.) Cameras and Photography	1.) Metric versus and non-metric	3	1	PHOTOGRAMMETRY SECTION
	2.) Calibration	4	3	PHOTOGRAMMETRY SECTION
	3.) Camera geometry and characteristics	4	3	PHOTOGRAMMETRY SECTION
	4.) Spatial resolution	4	3	PHOTOGRAMMETRY SECTION
B.) Radiometry, Detection, and Sensing	1.) Optics	2	1	PHOTOGRAMMETRY SECTION
	2.) Aperature, shutter, radiometry	2	1	PHOTOGRAMMETRY SECTION
	3.) Image motion compensation	4	3	PHOTOGRAMMETRY SECTION
	Detector			PHOTOGRAMMETRY SECTION
C.) Frame Geometry	1.) Perspective geometry or pinhole camera	2	1	PHOTOGRAMMETRY SECTION
	2.) Graphical solutions using perspective	2	1	PHOTOGRAMMETRY SECTION
	3.) Scale and field of view	2	1	PHOTOGRAMMETRY SECTION
	4.) Relief displacement	2	1	PHOTOGRAMMETRY SECTION
	5.) Tilt displacement	2	1	PHOTOGRAMMETRY SECTION
	6.) Interior and exterior orientation	2	1	PHOTOGRAMMETRY SECTION
D.) Imaging Measurements	1.) Reference coordinate system	4	3	PHOTOGRAMMETRY SECTION
	2.) Systematic errors and correction	4	3	PHOTOGRAMMETRY SECTION
E.) Stereoscopy and Parallax	1.) Depth perception and parallax	5	3	PHOTOGRAMMETRY SECTION
	2.) Base-height ratio and vertical exaggeration	5	3	PHOTOGRAMMETRY SECTION
	3.) Stereoscopes	5	3	PHOTOGRAMMETRY SECTION
F.) Mathematical Modeling and Analytical Photogrammetry	1.) Collinearity equation	2	3	PHOTOGRAMMETRY SECTION
	2.) Coplanitary equation	2	3	PHOTOGRAMMETRY SECTION
	3.) Object space coordinate systems and transformations	2	3	PHOTOGRAMMETRY SECTION
	4.) Image resection	4	3	PHOTOGRAMMETRY SECTION
	5.) Space intersection	1	1	PHOTOGRAMMETRY SECTION
	6.) Bundle block adjustment	4	3	PHOTOGRAMMETRY SECTION
	7.) Relative and absolute orientation	4	3	PHOTOGRAMMETRY SECTION
	8.) Independent models, strip information, and adjustment by polynomials	4	3	PHOTOGRAMMETRY SECTION
	9.) Platform and trajectory modeling	2	3	PHOTOGRAMMETRY SECTION
G.) Computer Vision	1.) Homogeneous coordinates	5	3	PHOTOGRAMMETRY SECTION
	2.) Fundamental and essential matrices	4	3	PHOTOGRAMMETRY SECTION
	3.) Eight point algorithm	4	3	PHOTOGRAMMETRY SECTION
	4.) Synthetic image generation	1	1	PHOTOGRAMMETRY SECTION
	5.) Automation and feature extraction	5	5	PHOTOGRAMMETRY SECTION
H.) Estimation, Adjustment, Statistics, and Error Propagation	1.) Measurement errors	4	5	PHOTOGRAMMETRY SECTION
	2.) Objective functions and adjustments	3	4	PHOTOGRAMMETRY SECTION
	3.) Functional and stochastic models	3	3	PHOTOGRAMMETRY SECTION
	4.) Least squares techniques	3	3	PHOTOGRAMMETRY SECTION
	5.) Constraints	4	3	PHOTOGRAMMETRY SECTION
	6.) Error propagation, hypothesis testing, confidence statements	4	3	PHOTOGRAMMETRY SECTION
	7.) Unified least squares	4	3	PHOTOGRAMMETRY SECTION
	8.) Sequential estimation and kalman filter	3	3	PHOTOGRAMMETRY SECTION
	9.) Robust estimation	3	3	PHOTOGRAMMETRY SECTION
I.) Stereo Restitution	1.) Analytical projection	2	1	PHOTOGRAMMETRY SECTION
	2.) Digital stereo workstation	5	5	PHOTOGRAMMETRY SECTION
	3.) Pairwise rectification	4	3	PHOTOGRAMMETRY SECTION

J.) Rectification and Resampling	1.) Interpolation and aggregation	4	3	PHOTOGRAMMETRY SECTION
	2.) Nyquist sampling theorem and aliasing	1	1	PHOTOGRAMMETRY SECTION
	3.) Simple rectification (tilt correction only)	4	3	PHOTOGRAMMETRY SECTION
	4.) Ortho rectification (tilt and terrain correction)	4	3	PHOTOGRAMMETRY SECTION
	5.) True orthorectification (tilt, terrain, and building correction)	4	3	PHOTOGRAMMETRY SECTION
K.) Mapping and Cartography	1.) Enlargement factor versus contrast and spatial resolution	4	3	PHOTOGRAMMETRY SECTION
	2.) Map projections and reference coordinate systems	4	3	PHOTOGRAMMETRY SECTION
	3.) National map accuracy standards	3	3	PHOTOGRAMMETRY SECTION
	4.) National map series	2	2	PHOTOGRAMMETRY SECTION
	5.) Urban and project oriented mapping	4	3	PHOTOGRAMMETRY SECTION
	6.) Software environments	5	5	PHOTOGRAMMETRY SECTION
L.) Topography and Digital Elevation Modeling	1.) Grid/raster collection	4	3	PHOTOGRAMMETRY SECTION
	2.) Unstructured point collection	4	3	PHOTOGRAMMETRY SECTION
	3.) Triangular irregular network processing	5	5	PHOTOGRAMMETRY SECTION
	4.) Breakline processing	5	5	PHOTOGRAMMETRY SECTION
	5.) Profiles and cross sections for road design	4	4	PHOTOGRAMMETRY SECTION
M.) Digital Photogrammetry	1.) Image normalization	3	3	PHOTOGRAMMETRY SECTION
	2.) Image matching	3	3	PHOTOGRAMMETRY SECTION
	3.) Surface reconstruction, DEM generation	5	5	PHOTOGRAMMETRY SECTION
	4.) Automatic relative orientation	4	3	PHOTOGRAMMETRY SECTION
N.) Project Planning	1.) Accuracy requirements	5	3	PHOTOGRAMMETRY SECTION
	2.) Control point selection	5	3	PHOTOGRAMMETRY SECTION
	3.) GPS/INS supported imaging	5	3	PHOTOGRAMMETRY SECTION
	4.) Flightline layout	4	2	PHOTOGRAMMETRY SECTION
O.) Close-Range Photogrammetry	1.) Nonmetric cameras	3	2	PHOTOGRAMMETRY SECTION
	2.) Optics selection, self-calibration	3	2	PHOTOGRAMMETRY SECTION
	3.) Fixed baseline rigs	3	2	PHOTOGRAMMETRY SECTION
	4.) Structured light	3	2	PHOTOGRAMMETRY SECTION
P.) Satellite Photogrammetry	1.) Orbit mechanics	0	0	PHOTOGRAMMETRY SECTION
	2.) Coordinate systems	3	3	PHOTOGRAMMETRY SECTION
	3.) Time systems	0	0	PHOTOGRAMMETRY SECTION
	4.) Projection models	3	3	PHOTOGRAMMETRY SECTION
	5.) Ephemeris and support data	0	0	PHOTOGRAMMETRY SECTION
Q.) Remote Sensing	1.) Spectral coverage	3	2	PHOTOGRAMMETRY SECTION
	2.) Classification	3	2	PHOTOGRAMMETRY SECTION
	3.) Change detection	2	1	PHOTOGRAMMETRY SECTION
R.) Active Sensing with LiDAR	1.) Acquisition platforms	3	1	PHOTOGRAMMETRY SECTION
	2.) Point cloud processing	5	3	PHOTOGRAMMETRY SECTION
	3.) Feature extraction	5	3	PHOTOGRAMMETRY SECTION
	4.) Mobile versus static data acquisition	5	3	PHOTOGRAMMETRY SECTION
	5.) Standards and quality issues	5	5	PHOTOGRAMMETRY SECTION
S.) Applications	1.) Mapping	5	5	PHOTOGRAMMETRY SECTION
	2.) Resource inventory	5	1	PHOTOGRAMMETRY SECTION
	3.) 3D object reconstruction	3	2	PHOTOGRAMMETRY SECTION
	4.) Medical application	2	1	PHOTOGRAMMETRY SECTION
	5.) GIS database population	3	2	PHOTOGRAMMETRY SECTION

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priorit

GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)

GDOT Personnel Responsibility Level; TBD

Knowledge Area	GDOT Priority - TP	GDOT Priority - A	GDOT Frequency - T	GDOT Frequency - AF
A.) Cameras and Photography	15	3.75	10	2.50
B.) Radiometry, Detection, and Sensing	8	2.67	5	1.67
C.) Frame Geometry	12	2.00	6	1.00
D.) Imaging Measurements	8	4.00	6	3.00
E.) Stereoscopy and Parallax	15	5.00	9	3.00
F.) Mathematical Modeling and Analytical Photogrammetry	25	2.78	25	2.78
G.) Computer Vision	19	3.80	15	3.00
H.) Estimation, Adjustment, Statistics, and Error Propagation	31	3.44	30	3.33
I.) Stereo Restitution	11	3.67	9	3.00

J.) Rectification and Resampling	17	3.40	13	2.60
K.) Mapping and Cartography	22	3.67	19	3.17
L.) Topography and Digital Elevation Modeling	22	4.40	20	4.00
M.) Digital Photogrammetry	15	3.75	14	3.50
N.) Project Planning	19	4.75	11	2.75
O.) Close-Range Photogrammetry	12	3.00	8	2.00
P.) Satellite Photogrammetry	6	1.20	6	1.20
Q.) Remote Sensing	8	2.67	5	1.67
R.) Active Sensing with LiDAR	23	4.60	15	3.00
S.) Applications	18	3.60	11	2.20
Total	306	3.48	237	2.60

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Surveying-Geomatics Body of Knowledge Scope: Land Stewardhip				
Knowledge Area	**Associated Task**	**GDOT Priority**	**GDOT Frequency**	**GDOT Personnel Responsibility Level**
A.) Communication Skills	1.) Situational analysis	2	1	SPC AND ABOVE
	2.) Objective reasoning	2	1	SPC AND ABOVE
	3.) Clarity of expression	2	1	SPC AND ABOVE
	4.) Command of language	2	1	SPC AND ABOVE
	5.) Physical presentation	2	1	SPC AND ABOVE
	6.) Adaption of explanations	2	1	SPC AND ABOVE
	7.) Listening skills	2	1	SPC AND ABOVE
	8.) Negotiating skills	2	1	SPC AND ABOVE
	9.) Ability to debate	2	1	SPC AND ABOVE
	10.) Logic	2	1	SPC AND ABOVE
B.) Site Design and Resource Management	1.) Identify existing balance of human and environment factors	1	0	SPC AND ABOVE
	2.) Evaluate and present current and future site context	1	0	SPC AND ABOVE
	3.) Awareness of existing and and evolving development patterns	1	0	SPC AND ABOVE
	4.) Ability to incorporate principles of sustainability to site design and development	1	0	SPC AND ABOVE
	5.) Identification of site resources	1	0	SPC AND ABOVE
	6.) Federal laws and regulations affecting site development	1	0	SPC AND ABOVE
	7.) Local ordinances affecting site development	1	0	SPC AND ABOVE
	8.) Interrelationship of legal requirements	1	0	SPC AND ABOVE
C.) Site Constraints	1.) Assess site suitability relative to a given plan or design	1	0	SPC AND ABOVE
	2.) Identification of specific impacts (positive and negative) from proposed development	1	0	SPC AND ABOVE
D.) Project Administration, Management, and Organization	1.) Contractual responsibilities	1	0	SPC AND ABOVE
	2.)Legal responsibilities	1	0	SPC AND ABOVE
	3.) Professional responsibilities	1	0	SPC AND ABOVE
	4. Estimation of time, staffing, equipment, and material requirements	3	3	SPC AND ABOVE
	5.) Apply principles of time and staff management	3	3	SPC AND ABOVE
	6.) Apply principles of measurement, imaging, and positioning	4	4	SPC AND ABOVE
	7.) Assess a project by technical, procedural, and timing requirements	4	4	SPC AND ABOVE
	8.) Assess staffing abilties and needs	4	4	SPC AND ABOVE

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
GDOT Personnel Responsibility Level; TBD

Knowledge Area	GDOT Priority - TP	GDOT Priority - AP	GDOT Frequency - TP	GDOT Frequency - AP
A.) Communication Skills	20	2.00	10	1
B.) Site Design and Resource Management	8	1.00	0	0
C.) Site Constraints	2	1.00	0	0
D.) Project Administration, Management, and Organization	21	2.63	18	2.25
Total	51	1.66	28	0.81

C-5

Surveying-Geomatics Body of Knowledge Scope: Legal Aspects				
Knowledge Area	**Associated Task**	**GDOT Priority**	**GDOT Frequency**	**GDOT Personnel Responsibility Level**
A.) Legal Systems	1.) Legal methods and processes	3	2	SPC AND ABOVE
	2.) Court systems	3	2	SPC AND ABOVE
	3.) Civil procedures	3	2	SPC AND ABOVE
	4.) Evidence and procedures (forms and rules) of evidence	3	2	SPC AND ABOVE
B.) Legal Resources	1.) Legal research	5	4	SPC AND ABOVE
	2.) Courthouse research	5	4	SPC AND ABOVE
	3.) Statutory law	2	3	SPC AND ABOVE
	4.) Administrative law	2	2	SPC AND ABOVE
	5.) Judicial decisions and common law	2	2	SPC AND ABOVE
	6.) Executive orders	2	2	SPC AND ABOVE
B.) Law and Business	1.) Written, oral, and physical presentation and communication skills	2	1	SPC AND ABOVE
	2.) Understanding of the nature, types, elements, and obligations of contracts (including limitations and breach of contract)	2	1	SPC AND ABOVE
	3.) Understanding of torts, negligence, and standards of care	2	1	SPC AND ABOVE
	4.) Copyright law	2	1	SPC AND ABOVE
	5.) Business entities and agency and partnership relationships	2	1	SPC AND ABOVE
	6.) Digital and electronic record keeping	4	5	SPC AND ABOVE
	7.) Liability, errors, and omissions	4	4	SPC AND ABOVE
	8.) Professionalism, ethics, and supporting certifications and licensures	5	4	SPC AND ABOVE

GDOT Priority (importance); (Scale 0-5, where 0 = No priority or unsure, 1 = minimal priority, 2 = low priority, 3 = moderate priority, 4 = high priority, 5 = highest priority or necessity)
GDOT Performance Frequency; (Scale 0-5, where 0 = never, 1 = seldom, 2 = quarterly, 3 = monthly, 4 = weekly and 5 = daily)
GDOT Personnel Responsibility Level; TBD

Knowledge Area	GDOT Priority - TP	GDOT Priority - AP	GDOT Frequency - TP	GDOT Frequency - AP
A.) Legal Systems	12	3.00	8	2.00
B.) Legal Resources	18	3.00	17	2.83
B.) Law and Business	23	2.88	18	2.25
Total	53	2.96	43.00	2.36

APPENDIX D: SURVEYING-GEOMATICS EMPLOYMENT POSITIONS IN GEORGIA

Position Title	GDOT-SG CATEGORY	GSU-SG CATEGORY	Public/ Pvt	City	State	Employer Name	Employer Dept. Name	Work Location: (Field/ Office/ Combo)	Licensure Req: (LSIT, PLS, other)	Education Req: (AS, BS, MS, PhD, other)	Experience Req: (# Years)	Experience Requirement: (In-house/ Outside/ NA)	Previous Position Required? (Y/N)	Work Description/Resp.: (Management/Production/ Combo)	S-G Software Exp. Req'd: (Y/N)	Geospatial (GIS, RS, IP) Software Exp. Req'd.:(Y/N)	Salary (if given): ($K)	Medical Benefits: (Y/N)	Retirement Benefits: (Y/N)
Senior Survey Technician	GDOT -SG 05	GSU - SG 03	Public	Riverside	CA	County of Riverside	Geodetic Division	Comb	LSIT	BS	2–5	In-house	N	Production	Y	Y	$27-$44/hr	N	N
Survey CAD Technician	GDOT -SG 05	GSU - SG 03	Public	Colorado Spring	CO	Compass surveying and Mapping, LLC	Survey Team	Office	LSIT	BS	05–10	Outside	Y	Production	Y	Y	76K-99K	N/A	N/A
Geospatial Data Manager	GDOT -SG 04	GSU - SG 04	Public	Tulsa	OK	US Army Corps of Engineers	Army Corps	Comb	PLS	BS	2–5	NA	Y	Production	Y	Y	54K	Y	Y
GIS Technician	GDOT -SG 07	GSU - SG 05	Public	Hinesville	GA	City of Hinesville	Survey Team	Office	NA	BS	2	NA	Y	Production	Y	Y	38K	Y	Y
GIS Intern	GDOT -SG 07	GSU - SG 05	Public	Sandy Springs	GA	City of Sandy Spring	Survey Dept	Office	NA	BS	0	NA	N	Production	Y	N	$18/hr	N	N
GIS Specialist	GDOT -SG 07	GSU - SG 05	Public	Oconee County	GA	City of Oconee	Survey Dept	Office	NA	BS	1	NA	N	Production	Y	N	34K	N	N
Project Surveyor	GDOT SG 08	GSU - SG 05	Public	Mentor	OH	CT Consultants	Land services Market	Comb	PLS	AS/ BS	05–10	In-house	Y	Management	Y	Y	$65K	Y	Y
Right of way Officer	GDOT SG 08	GSU - SG 05	Public	Grand Fork	ND	Grand Fork	Infrastructure	Field	PLS	AS/ BS	2	NA	Y	Management	Y	Y	$61K-$81K	Y	NA
Professional Land Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Des Moines	IO	HR Green	Survey Team	Comb	PLS	BS	5	NA	Y	Management	Y	Y	$67K	Y	Y
Location Bureau Chief	GDOT -SG 01	GSU - SG 07	Public	Atlanta	GA	GDOT	Location bureau	Comb	NA	NA	7	In-house	Y	Management	Y	Y	$66-$116K	Y	Y
Engineering operations Manager	GDOT -SG 02	GSU - SG 04	Public	Atlanta	GA	GDOT	Survey Team	Office	NA	NA	2	In-house	Y	Production	Y	Y	$52-$91K	Y	Y
Consultant Compliance Supervisor	GDOT -SG 03	GSU - SG 06	Public	Atlanta	GA	GDOT	Survey Team	Office	NA	NA	2	In-house	Y	Production	Y	Y	$40K-$71K	Y	Y

Statewide Survey data Specialist	GDOT -SG 04	GSU - SG 04	Pub lic	Atlanta	G A	GDOT	Survey Team	Offic e	NA	NA	2	In- house	Y	Production	Y	Y	$40K- $71K	Y	Y
Asst. statewide Survey data Specialist	GDOT -SG 04	GSU - SG 04	Pub lic	Atlanta	G A	GDOT	Survey Team	Offic e	NA	NA	2	In- house	Y	Production	Y	Y	$32- 57K	Y	Y
Assistant CCS	GDOT -SG 03	GSU - SG 06	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	2	In- house	Y	Production	Y	Y	$32K- $57K	Y	Y
Statewide Cadastral Supervisor	GDOT -SG 03	GSU - SG 06	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	3	In- house	Y	Production	Y	Y	$40- $71K	Y	Y
Statewide Geodetic Supervisor	GDOT -SG 03	GSU - SG 06	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	2	In- house	Y	Production	Y	Y	$32- $57K	Y	Y
Computation s Technician	GDOT -SG 05	GSU - SG 03	Pub lic	Atlanta	G A	GDOT	Survey Team	Offic e	NA	NA	2	In- house	NA	Production	NA	NA	$27- $47K	Y	Y
Quality Assurance Supervisor	GDOT -SG 03	GSU - SG 06	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	1	In- house	NA	Production	NA	NA	$40- $71K	Y	Y
Survey Party Chief	GDOT -SG 06	GSU - SG 02	Pub lic	Atlanta	G A	GDOT	Survey Team	Field	NA	NA	1	In- house	NA	Production	NA	NA	$29- $52K	Y	Y
Asst. SPC	GDOT -SG 06	GSU - SG 02	Pub lic	Atlanta	G A	GDOT	Survey Team	Field	NA	NA	2	In- house	NA	Production	NA	NA	$27K- $47K	Y	Y
Surveying Technician 2	GDOT -SG 05	GSU - SG 03	Pub lic	Atlanta	G A	GDOT	Survey Team	Field	NA	NA	2	In- house	NA	Production	NA	NA	$24K- $43K	Y	Y
Surveying Technician 1	GDOT -SG 05	GSU - SG 03	Pub lic	Atlanta	G A	GDOT	Survey Team	Field	NA	NA	NA	In- house	NA	Production	NA	NA	$22K- $38K	Y	Y
Location Manager	GDOT -SG 02	GSU - SG 04	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	NA	In- house	NA	Production	NA	NA	$40K- $71K	Y	Y
Resident Survey Manager	GDOT -SG 02	GSU - SG 04	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	NA	In- house	NA	Production	NA	NA	$32K- $57K	Y	Y
Survey Data Specialist	GDOT -SG 07	GSU - SG 05	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	1	In- house	NA	Production	NA	NA	$29K- $52K	Y	Y
Survey Party Chief	GDOT -SG 06	GSU - SG 02	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	NA	In- house	NA	Production	NA	NA	$29K- $52K	Y	Y
Asst. SPC	GDOT -SG 06	GSU - SG 03	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	NA	In- house	NA	Production	NA	NA	$29K- $52K	Y	Y
Survey Technician 2	GDOT -SG 05	GSU - SG 03	Pub lic	Atlanta	G A	GDOT	Survey Team	Com b	NA	NA	NA	In- house	NA	Production	NA	NA	$29K- $52K	Y	Y
Land Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	North Las Vegas	N V	Sunrise Engineeri ng	Land Survey	Com b	PLS /LSI T	BS	5	NA	Y	Production	Y	y	$30K- $42K	NA	NA
Professional Land Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Medford	OR	OBEC Consultin g Engineers	Land Survey	Field	PLS	BS	2	NA	Y	Production	Y	Y	$49- $55K	NA	NA
Professional Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Charlotte	NC	EMH & T	Land Survey	Com b	PLS	BS	8	NA	Y	Production	Y	Y	$50K- $56K	NA	NA
Professional Land Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Millersvil le	M D	Davey Tree	Land Survey	Com b	PLS	BS	5	NA	Y	Production	Y	Y	$50- $56K	NA	NA

Solar Land Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Denton	G A	Mortenso n	Land Survey	Com b	PLS	BS	2	NA	Y	Production	Y	Y	$45K- $55K	NA	NA
Survey (Civil)	GDOT -SG 05	GSU - SG 03	Pvt	Golden City	M O	Mortenso n	Land Survey	Com b	PLS	BS	2	NA	Y	Production	Y	Y	$37K- $45K	NA	NA
Dry Cargo Surveyor	GDOT -SG 05	GSU - SG 01	Pvt	Los Angeles	CA	Bureau Veritas	Land Survey	Com b	PLS	BS	7	NA	Y	Production	Y	Y	$50K- $60K	NA	NA
Entry Level Surveyor	GDOT -SG 05	GSU - SG 01	Pvt	Orlando	FL	Dewberry	Survey Team	Com b	PLS	BS	NA	NA	NA	Production	Y	Y	$27K- $47K	NA	NA
Project Surveyor	GDOT SG 08	GSU - SG 03	Pvt	Portland	OR	David Evans & Assoc.	Survey Team	Com b	PLS	BS	5	NA	NA	Production	Y	Y	$47K- $55K	Y	Y
Staff Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Knoxville	TN	Surveying & Mapping	Survey Team	Com b	PLS	BS	2	NA	NA	Production	NA	Y	$47K- $57K	Y	Y
Surveyor/Dr after	GDOT -SG 05	GSU - SG 03	Pvt	Salina	UT	Bowie Resources	Survey Team	Com b	PLS	BS	2	NA	NA	Production	Y	Y	$45K- $55K	Y	NA
Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Dallas	TX	CP & Y	Survey Team	Com b	PLS	BS	5	NA	NA	Production	Y	Y	$37K- $42K	NA	NA
Surveyor	GDOT -SG 05	GSU - SG 03	Pvt	Los Angeles	CA	Skansa USA building	Survey Team	Field	PLS /RL S/P E	BS	5	NA	NA	Production	Y	Y	$32K- $40K	NA	NA
GIS Technician	GDOT -SG 05	GSU - SG 03	Pvt	Aurora	CO	Graebel Van Lines	Survey Team	Field	PLS	BS	2	NA	NA	Production	NA	NA	$32K- $40K	NA	NA
GIS Programmer	GDOT -SG 07	GSU - SG 05	Pub lic	Hinesville	G A	City of Hinesville	Inspecti on Dept	Offic e	PLS	BS	2	NA	Y	Production	Y	Y	$32K	NA	NA
Surveyor Manager	GDOT -SG 07	GSU - SG 05	Pvt	Savannah	G A	Brandon Batt	Survey Team	Offic e	PLS	BS	3	NA	NA	Production	Y	Y	NA	NA	NA
Land Surveyor	GDOT -SG 02	GSU - SG 04	Pvt	Cleveland	O H	Cleveland Metropark s	Survey Team	Offic e	PLS	BS	NA	NA	NA	Management	Y	Y	$59K- $89K	NA	NA
Land Surveyor	GDOT -SG 05	GSU - SG 03	Pub lic	Reno	N V	Bureau of Land Managem ent	Dept of Interior	Offic e	NA	BS	Y	Y	Y	Production	Y	Y	$76K- $99	Y	Y
Land Surveyor	GDOT -SG 05	GSU - SG 03	Pub lic	Bozeman	M T	Dept of Agricultur e	Forestr y	Offic e	NA	BS	NA	NA	NA	Production	Y	Y	$39K- $43K	Y	Y
Land Surveyor	GDOT -SG 05	GSU - SG 03	Pub lic	Helena	M T	Dept of Agricultur e	Forestr y	Offic e	NA	BS	NA	NA	NA	Production	Y	Y	$39K- $43K	Y	Y
Land Surveyor	GDOT -SG 05	GSU - SG 03	Pub lic	Butte	M T	Dept of Agricultur e	Forestr y	Offic e	NA	BS	NA	NA	NA	Production	Y	Y	$39K- $43K	Y	Y
Transportati on Tech 1	GDOT -SG 05	GSU - SG 03	Pub lic	Dickinson	N D	Dept of Agricultur e	Forestr y	Offic e	NA	BS	NA	NA	NA	Production	Y	Y	$39K- $43K	Y	Y
Survey Party Chief - Land	GDOT -SG 05	GSU - SG 03	Pub lic	Jesup	G A	GDOT	Transpo rtation	Com b	NA	AS	NA	NA	NA	Production	NA	N	$28K	N	N
Survey Party Chief	GDOT -SG 06	GSU - SG 02	Pvt	Lafayette	LA	Fugro	Survey Team	Field	NA	BS	NA	NA	NA	Production	Y	Y	NA	NA	NA
Crew Chief	GDOT -SG 06	GSU - SG 02	Pvt	Chesapea ke	V A	Parsons Commerci al Tech	Survey Team	Field	NA	BS	5	NA	NA	Production	Y	Y	NA	NA	NA

Survey Crew Chief	GDOT -SG 06	GSU - SG 02	Pvt	Conyers	G A	Patrick & Associates, Inc	Survey Team	Field	NA	BS	NA	NA	NA	Production	Y	Y	NA	NA	NA
Crew Chief	GDOT -SG 06	GSU - SG 02	Pvt	McDonough	G A	Jacob's Engineering Group	Survey Team	Field	NA	BS	NA	NA	NA	Production	Y	Y	NA	NA	NA
Crew Chief	GDOT -SG 06	GSU - SG 02	Pvt	McDonough	G A	Land Engineering	Survey Team	Field	NA	BS	NA	NA	NA	Production	Y	Y	NA	Y	Y
Survey CAD Technician	GDOT -SG 06	GSU - SG 02	Pvt	Lawrenceville	G A	Atwell, LLC	Survey Team	Field	NA	AS	5	NA	NA	Production	Y	Y	NA	NA	NA
Instrument Man	GDOT -SG 05	GSU - SG 03	Pvt	Lawrenceville	G A	Atwell, LLC	Survey Team	Field	NA	BS	3	NA	NA	Production	Y	Y	NA	NA	NA
Crew Assistant	GDOT -SG 05	GSU - SG 03	Pvt	Stockbridge	G A	Falcon Design Consultants	Survey Team	Field	NA	AS	1	NA	NA	Production	N	Y	NA	Y	N
	GDOT -SG 06	GSU - SG 02	Pvt	Douglasville	G A	HRC	Survey Team	Field	NA	AS	1	NA	NA	Production	N	Y	NA	Y	N

APPENDIX E: SURVEYING-GEOMATIC POSITIONS IN CALTRANS

Position Title	Public/ Pvt	City	State	Employer Name	Employer Dept. Name	Work Location: Field/Office/Comb	Licensure Requirement: (LSIT, PLS, other)	Education Requirement: (AS, BS, MS, PhD, other)	Experience Requirement: # Years	Experience Requirement: (In-house/Outside/NA)	Previous Position Required? Y/N	Work Description/Responsibilities: (Management/Production/ Combo)	S-G Software Exp. Req (Y/N)	Geospatial (GIS, RS, IP) Software Exp. Req'd. (Y/N)	Salary if given: ($K)	Medical Benefits (Y/N)	Retirement Benefits: (Y/N)
Party Chief	Public	Sacramento	CA	Caltrans	DOT	Comb	PLS	BS	NA	NA	Y	Comb	Y	Y	$7k-$10k	NA	NA
Transportation Surveyor	Public	Santa Clara	CA	Caltrans	DOT	Office	LSIT	BS	NA	NA	N	Production	Y	Y	$5-$10k	NA	NA
Transportation Surveyor	Public	Alameda	CA	Caltrans	DOT	Office	LSIT	BS	NA	NA	N	Production	Y	Y	$5-$10k	NA	NA
Transportation Surveyor	Public	Stockton	CA	Caltrans	DOT	Office	LSIT	BS	NA	NA	N	Production	Y	Y	$5-$10k	NA	NA
Transportation Surveyor	Public	Fresno	CA	Caltrans	DOT	Office	LSIT	BS	NA	NA	N	Production	Y	Y	$5-$10k	NA	NA
Transportation Survey Party Chief	Public	Bishop	CA	Caltrans	DOT	Field	NA	NA	NA	NA	N	Production	N	Y	$8-$10K	NA	NA
Transportation Survey Party Chief	Public	Shasta	CA	Caltrans	DOT	Field	CLS	NA	NA	NA	N	Production	N	Y	$8-$10K	NA	NA
Transportation Surveyor	Public	Bishop	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Production	Y	Y	$5-$10k	NA	NA
Project Surveyor	Public	Marysville	CA	Caltrans	DOT	Field	NA	NA	NA	NA	N	Production	Y	Y	$5-$10k	NA	NA
Transportation Engineering Tech.	Public	Riverside	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Production	N	Y	$3- $5k	NA	NA
Transportation Engineering Tech.	Public	San Bern.	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Production	N	Y	$3- $5k	NA	NA
Staff Services Manager I	Public	Sacramento	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Production	N	N	$5-$6k	NA	NA
Staff Services Manager II	Public	Sacramento	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Production	N	N	$7-$8	NA	NA
Project Supervisor	Public	Marysville	CA	Caltrans	DOT	Field	NA	NA	NA	NA	NA	Comb	N	Y	$5-$10K	NA	NA

APPENDIX F: SURVEYING-GEOMATICS JOBS IN CALIFORNIA

Position Title	Public/ Pvt	City	State	Employer Name	Email Address	Employer Dept. Name	Work Location: Field/Office/Comb	Licensure Requirement: (LSIT, PLS, other)	Education Requirement: (AS, BS, MS, PhD, other)	Experience Requirement: # Years	Experience Requirement: (In-house/Outside/NA)	Previous Position Required? Y/N	Work Description/Responsibilities: (Management/Production/ Combo)	S-G Software Exp. Req'd. (Y/N)	Geospatial (GIS, RS, IP) Software Exp. Req'd. (Y/N)	Salary if given: ($K)	Medical Benefits (Y/N)	Retirement Benefits: (Y/N)
Land Surveyor	Pvt	California City	CA	GPAC	NA	Management	Office	PLS	NA	5	NA	Y	Management	Y	Y	NA	NA	NA
Land Surveyor	Pvt	Eureka	CA	Omsberg & Preston	NA	Survey Team	Comb	LSIT	NA	2	NA	N	Production	Y	Y	NA	NA	NA
Asst. Land surveyor	Public	Sacramento	CA	Sacramento County	NA	Survey Team	Field	LSIT	BS	1	NA	NA	Production	Y	Y	NA	NA	NA
Land Surveyor	Pvt	Los Angeles	CA	KPFF	NA	Survey Team	Field	NA	NA	0-3	NA	NA	Production	NA	NA	NA	NA	NA
Project Surveyor	Pvt	Santa Clarita	CA	David Evans & Assoc. Inc	NA	Survey Team	Comb	LSIT	NA	NA	NA	NA	Production	Y	Y	NA	Y	NA
Land Surveyor	Pvt	Roseville	CA	Evolvinc	NA	Survey Team	Comb	LSIT	NA	5	NA	NA	Production	Y	Y	NA	NA	NA
Asst. Land surveyor	Public	San Diego	CA	San Diego City	NA	Survey Team	Field	LSIT	BS	NA	NA	NA	Production	Y	Y	$81K-$101K	NA	NA
Principal Survey Aide	Public	San Diego	CA	San Diego City	NA	Survey Team	Field	LSIT	BS	NA	NA	NA	Production	Y	Y	$23/hr	NA	NA
Survey Associate	Public	San Francisco	CA	San Francisco	NA	Survey Team	Field	NA	NA	NA	NA	NA	Production	Y	Y	NA	N	NA
Land Technician	Pvt	San Francisco	CA	Pacific Gas & Electric company	NA	Distribution Team	Comb	LSIT/PLS	NA	NA	NA	NA	Comb	Y	Y	NA	NA	NA

Project Surveyor	Pvt	San Bernardino	CA	PSOMAS	NA	Survey Team	Comb	PLS	BS	NA	NA	NA	Comb	Y	Y	NA	Y	NA
Project Surveyor	Pvt	Willitis	CA	SHN Consulting Engineers	NA	Survey Team	Comb	LSIT	BS	5	NA	NA	Comb	Y	Y	$60-$80K	NA	NA
Land Surveyor	Pvt	Novato	CA	L.A Stevens & Associates	NA	Survey Team	Comb	PLS	BS	NA	NA	NA	Production	NA	Y	NA	NA	NA
Land Surveyor I/II	Pvt	Sonora	CA	Tuolumne County Public Health	NA	Survey Team	Field	LSIT	BS	2	NA	NA	Production	NA	Y	$33-$49/HR	NA	NA
Regional Director of Surveying	Pvt	Folson	CA	Toll Brothers	NA	Survey Team	Comb	NA	NA	NA	NA	NA	Comb	Y	Y	NA	NA	NA
Senior Survey Technician	Public	Riverside	CA	Riverside County	NA	Survey Team	Field	LSIT	BS	4	NA	NA	Production	Y	Y	NA	NA	NA
Civil Analyst/Land Surveyor	Pvt	San Diego	CA	Kimley-Horn & Associates., Inc	NA	Survey Team	Office	LSIT/EIT	BS/MS	NA	NA	NA	Production	Y	Y	NA	NA	NA
Associate Surveyor	Pvt	Fresno	CA	Towill, Inc.	NA	Survey Team	Field	LSIT	BS	5	NA	NA	Comb	Y	Y	NA	Y	NA
Professional Land Surveyor	Pvt	Oakland	CA	Mid Valley Engineering Inc	NA	Survey Team	Comb	PLS/LSIT	NA	5	NA	NA	Comb	Y	Y	$80-$110K	Y	NA
Land Senior Survey Supervisor	Pvt	Westminster	CA	Southern California Edison	NA	Survey Team	Field	NA	NA	NA	NA	NA	Comb	N	Y	NA	NA	NA
Survey Manager	Pvt	Anaheim	CA	GPAC	NA	Survey Team	Office	PLS	BS	NA	NA	NA	Management	NA	NS	NA	NA	NA
Project Surveyor	Pvt	Ontario	CA	David Evans & Assoc. Inc	NA	Survey Team	Field	NA	NA	NA	NA	NA	Production	NA	Y	NA	Y	NA
Professional Land Surveyor	Pvt	Pomona	CA	347 Group	NA	Survey Team	Field	PLS	BS	NA	NA	Y	Comb	NA	Y	$53-$100K	Y	NA
Professional Land Surveyor	Pvt	Bakersfield	CA	Encompass Energy Services	NA	Survey Team	Field	PLS	BS	5	NA	NA	Production	NA	Y	$52-$96K	Y	NA

Office Surveyor	Pvt	Walnut	CA	Shepherd Search Group	NA	Survey Team	Field	PLS	NA	3	NA	NA	Comb	N	Y	$57-$110K	NA	NA
Regional Director of Surveying	Pvt	Pleasanton	CA	Tolls Brother Inc.	NA	Survey Team	Comb	NA	NA	NA	NA	NA	Comb	N	Y	NA	Y	N
Civil Engineer/Land Planner	Pvt	Stockton	CA	TJG Civil Engineer & Land Planner	NA	Survey Team	Comb	PLS/LSIT	BS	NA	NA	NA	Production	N	Y	$36-$96K	Y	NA
Surveyor Support	Pvt	San Luis Obispo	CA	Tetra Tech Inc.	NA	Survey Team	Comb	NA	NA	10	NA	NA	Comb	NA	NA	NA	NA	NA
Site Surveyor	Pvt	Los Angeles	CA	Tesla	NA	Survey Team	Field	NA	NA	NA	NA	NA	Comb	Y	Y	$50-$110K	Y	NA
Utility Surveyor	Pvt	Upland	CA	Aerotek Tech	NA	Survey Team	Comb	NA	NA	NA	NA	NA	Comb	Y	NA	NA	Y	N

APPENDIX G: SURVEYING-GEOMATICS EDUCATION SUBJECT COVERAGE (GEORGIA STATEWIDE)

Ser	Course Prefix/ Number	Course Name	University/ College	Semester	Section	Credits	Lab Required	O=Online, F=face-to-Face, H=Hybrid	S=Synchronous, A=Asynchronous	Enrolled	GA BOR Course Designation (S1-S5+)	Instructor
Group- 01 (S1 and S2)												
1	SURV 2221	Surveying I	KSU	F2020	2	3	N	O,F	Online-A, Face-to-Face=S	54	S1	Shirazinejad, Branham
2	SURV 2200	Construction Measurements	KSU	F2020	2	4	Y	O	A, S	58	S1	Wilson, Devereux
3	SURV 2221L	Surveying I Lab	KSU	F2020	5	1	Y	O,F	S,A	64	S1	Shirazinejad, Branham
4	SURV 2110	Introduction to Mapping	KSU	F2019	1	4	Y	F	S	24	S2	Roberts
5	SURV 3222	Surveying II	KSU	F2020	1	3	Y	O	A	17	S2	Devereux
6	SURV 3222L	Surveying II Lab	KSU	F2020	1	1	Y	O	A	13	S2	Wilson
7	SURV 3330	Construction Surveying	KSU								S2	
Group- 02 (S3 and S4)												
8	SURV 4110	Geospatial Sciences Practice	KSU	F2020	1	3	Y	F	S	9	S3	Allen Roberts
9	SURV 4465	Legal Aspects of Land Surveying	KSU	F2020	1	4	N	O	A	12	S4	Matthew Wilson
10	SURV 4470	Land Development Design	KSU	S2020	1	3	Y	O	A	18	S4	Matthew Wilson
11	SURV 4475	Land Surveying Practice	KSU	S2020	1	2	N	F	S	13	S4	Matthew Wilson
Group- 03 (S5+)												
12	SURV 3320	Photogrammetry & Drone Analysis	KSU	F2020	1	3	Y	O	A	21	S5+	Roberts
13	SURV 3421	Geographic Information Systems I	KSU								S5+	
14	SURV 3441	Vector & Raster Analysis	KSU								S5+	
15	SURV 3451	Terrain Analysis	KSU	F2020	1	3	Y	O	A	10	S5+	Roberts
16	SURV 4410	Surveying Computations and Adjustments	KSU								S5+	

17	SURV 4415	Geodetic Surveying Methods	KSU								S5+	
18	SURV 4420	Remote Sensing	KSU	S2020	1	4	Y	O	A	14	S5+	Roberts
19	SURV 4422	Geographic Information Systems II	KSU								S5+	
Group- 01 (S1 and S2)												
1	TCM 2233	Construction Surveying	GSU	F2020	2	3	Y	F	S	60	S1	Purcell/ Wang
2	CENG 2231	Surveying	GSU	F2020	A	3	Y	O/ F **	S, A	24	S1	Nam
3	CENG 5431	Advanced Surveying	GSU	Su 2021		3	Y	O/ F **	S, A		S2	Purcell
4	CENG 5431G	Advanced Surveying	GSU	Su 2021		3	Y	O/ F **	S, A		S2	Purcell
Group- 02 (S3 and S4)												
5	CENG 5434	Surveying History & Law	GSU	S2021		3	N	O	A		S3	Purcell
6	CENG 5434G	Surveying History and Law	GSU	S2021		3	N	O	A		S3	Purcell
7	CENG 5438G	Surveying–Geomatics Professional Practice	GSU	F2021		3	N	O	A		S4	Purcell
8	CENG 5438	Surveying–Geomatics Professional Practice	GSU	F2021		3	N	O	A		S4	Purcell
Group- 03 (S5+)												
9	CENG 5432	Introduction to GIS in Surveying–Geomatics and Transportation	GSU	S2021		3	N	O	A		S5+	Hudson
10	CENG 5432G	Introduction to GIS in Surveying–Geomatics and Transportation	GSU	S2021		3	N	O	A		S5+	Hudson/ Purcell
11	CENG 5435	Introduction to Terrestrial LiDAR	GSU	F2020	1	3	Y	O/ F **	S, A	4	S5+	Maldonado
12	CENG 5435G	Introduction to Terrestrial LiDAR	GSU	F2020	1	3	Y	O/ F **	S, A	3	S5+	Maldonado
13	CENG 5436	Introduction to Close-Range Photogrammetry	GSU	S2021		3	Y	O/ F **	S, A		S5+	Maldonado
14	CENG 5436G	Introduction to Close-Range Photogrammetry	GSU	S2021		3	Y	O/ F **	S, A		S5+	Maldonado
** Online / Face to Face/ PLS (lab operation)												

Group- 01 (S1 and S2)												
1	ENVE 2221K	Surveying I	UNG	F2020	1	4	Y	H	S	22	S1	Hooks
2	ENVE 5221K	Geomatics I	UNG	F2020	1	4	Y	H	S	1	S1	Hooks
3	ENVE 2222K	Surveying II	UNG	S2020	1	4	Y	H		11	S2	Hooks
4	ENVE 5222K	Geomatics II	UNG	S2021							S2	Sherrill
Group- 02 (S3 and S4)												
5	ENVE 3465	Legal Aspects of Surveying	UNG	F2020	1	3	N	H	A	22	S3	Sherrill
6	ENVE 5465	Legal Aspects of Surveying	UNG	F2020	-	-	-	-	-	0	S3	Sherrill
7	ENVE 3475K	Professional Practice of Surveying	UNG	Sum 20	1	3	N	O	A	5	S4	Hooks
8	ENVE 5475K	Professional Practice of Surveying	UNG	Sum 20	1	3	N	O	A	1	S4	Hooks
Group- 03 (S5+)												
9	ENVE 4401K	Terrestrial LIDAR Methods	UNG								S5+	
10	ENVE 6401K	Terrestrial LIDAR Methods	UNG								S5+	
11	ENVE 4402K	Aerial Geomatics Methods	UNG								S5+	
12	ENVE 6402K	Aerial Geomatics Methods	UNG								S5+	
13	ENVE 1105K	Fundamentals of Unmanned Aerial Systems	UNG								S5+	
Group- 01 (S1 and S2)												
1	DRFT 2050	Surveying I	ATC	F2020	-	2	Y	H	-	-	S1	
2	CETC 1116	Surveying II	ATC	F2020	-	4	Y	H	-	-	S2	
Group- 02 (S3 and S4)												
3	CETC 1120	Evidence and Procedures for Boundary Location	ATC	F2020	-	4	Y	H	-	-	S3	
4	ENGT 2400	Surveying Internship	ATC	F2020	-	1	Y	H	-	-	S4	
Group- 03 (S5+)												
5	CETC 1119	GPS Surveying	ATC	F2020	-	3	Y	H	-	-	S5+	

APPENDIX H: QUESTIONS FOR VALIDATION

1. Creative methods to improve the enrollment of more students in the Georgia BOR's S1 to S5+ Surveying-Geomatics (S-G) courses (Please rank the answers where 1= first priority and 5 means least priority)
   a) ☐ Make a clear picture of the career plan among the potential students.
   b) ☐ Make a foresight of the likely path the S-G profession will take in the near future and orient it to the students.
   c) ☐ Stakeholders in the surveying profession should promote the profession and encourage the new generation.
   d) ☐ Target the college students with experimental marketing.
   e) ☐ Other

2. Methods to attract bright and creative students in the Geomatics field (Please rank the answers where 1= first priority and 5= least priority)
   a) ☐ Improve the availability of resources in labs.
   b) ☐ Increase the availability of skilled instructors familiar with the professional need.
   c) ☐ Increase more affordable admission requirements, tuition, and available scholarships.
   d) ☐ Increase more lucrative opportunities for students who will work under Professional Surveyor.
   e) ☐ Other

3. How to focus the available resources to improve student learning in the most efficient way? ((Please rank the answers where 1= first priority and 5= least priority)

   a) ☐ Curricula should be continuously updated; new technologies should be adopted in the syllabus.
   b) ☐ Experimental and problem-based learning approach provided in the S-G institutions
   c) ☐ Universities orient S-G education towards learning for all in a community of learners involving all stakeholders.
   d) ☐ Encourage the use of multimedia, animation, video conferencing, etc. for teaching students.
   e) ☐ Other

4. Improve the collaboration between the potential students and professionals for better exposure to Geomatics as a profession (Please rank the answers where 1= first priority and 5= least priority)

   a) ☐ Career Talks and public enlightenment campaign about the profession.
   b) ☐ Survey project-based classes should be provided for the surveying professionals.
   c) ☐ Provide campus events marketing and advertising.
   d) ☐ Introduction to the S-G profession in Civil Engineering introductory course.
   e) ☐ Other

APPENDIX I: PROJECT APPROVAL AND CONSENT DOCUMENTS

I-1

Institutional Review Board (IRB)
Veazey Hall 3000
PO Box 8005 • STATESBORO, GA 30460
Phone: 912-478-5465
Fax: 912-478-0719
IRB@GeorgiaSouthern.edu

To:	Scott, David; Maldonado, Gus; Nam, Soonkie
From:	Eleanor Haynes, Director, Research Integrity
Approval Date:	1/25/2021
Subject:	Institutional Review Board Exemption Determination - Limited Review

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Your proposed research project numbered **H21201,** and titled **"GDOT: Geomatic Educ Needs (Georgia Department of Transportation: Meeting the 21st Century Surveying-Geomatics Education Needs of GDOT and Georgia)."** involves activities that do not require full approval by the Institutional Review Board (IRB) according to federal guidelines.

According to the Code of Federal Regulations Title 45 Part 46, your research protocol is determined to be exempt from full review under the following exemption category(s):

Exemption 2 Research involving only the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, if: Information obtained is recorded in such a manner that human participants cannot be identified, directly or through identifiers linked to them. Please visit our FAQ's for more information on anonymous survey platforms; Any disclosure of the human participant's responses outside the research could not reasonably place the participant at risk of criminal or civil liability or be damaging to the participant's financial standing, employ-ability or reputation; Survey or interview research does not involve children; The research project does not include any form of intervention.

Any alteration in the terms or conditions of your involvement may alter this approval. *Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that your research, as submitted, is exempt from IRB Review. No further action or IRB oversight is required, as long as the project remains the same. If you alter the project, it is your responsibility to* *notify the IRB and acquire a new determination of exemption. Because this project was determined to be exempt from further IRB oversight, this project does not require an expiration date.*

I-2

COLLEGE OF ENGINEERING AND COMPUTING

DEPARTMENT OF CIVIL ENGINEERING AND CONSTRUCTION

Informed Consent
for
Meeting the 21st Century Surveying-Geomatics Education Needs of GDOT and Georgia Project Survey

1. Research Team (All members are faculty or students of the Department of Civil Engineering and Construction at Georgia Southern University):
    a. PI: Dr. David Scott (Dept. Chair)
    b. Co-PI: Dr. Gus Maldonado (Faculty)
    c. Co-PI: Dr. Soonkie Nam (Faculty)
    d. Imran Kays (Graduate Research Assistant)
    e. Usman Ibrahim (Graduate Research Assistant)
    f. Connor Cantrell (Undergraduate Research Assistant)
    g. Dr. Roger Purcell (Former PI, Current Part-time Faculty)

   All members of the team are performing this work in an effort to support the improvement of Surveying-Geomatics education for the Georgia Department of transportation and the State of Georgia.

2. Purpose of the Study: The purpose of this research is to provide a viable solution to the lack of Surveying-Geomatics education availability for place-bound students, traditional residential students and the associated lack of availability of new employees and existing GDOT personnel that are properly educated in Surveying-Geomatics for the 21st Century.

3. Procedures to be followed for this survey which supports the project research: Participation in this survey will include completion of 51 multiple-choice and fill-in questions. Submission of the survey will prompted for the participant at the end of the survey.

4. Risks: Google Forms will be used for the online version of the survey and IP addresses will not be identified or collected by the research team with the survey submission. If Google collects IP addresses from the devices used to complete the survey, we will not request or obtain that information from Google. Thus, all survey submissions will remain completely anonymous to the research team.

5. Benefits:
   a. The benefits to you as a participant: As a participant, you will receive the indirect benefit of having access to the information gleaned form this research and this survey as made available by the Georgia Department of Transportation.
   b. The benefits to society, in particular to residents of Georgia, will be a larger and better educated workforce in Surveying-Geomatics.

6. Duration/Time required from the participant: The estimated time to take the survey is 20 minutes.

7. Statement of Confidentiality: Data will be made available to the members of the research team and will be maintained on a shared drive provided by Georgia Southern University. Data will be kept in a secure location at all times for a minimum of 3 years following completion of the study.

8. Future use of data: Deidentified or coded data from this study may be placed in a publically available repository for study validation and further research. You will not be identified by name in the data set or any reports using information obtained from this study, and your confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.

9. Right to Ask Questions: Participants have the right to ask questions and have those questions answered. If you have questions about this study, please contact the researcher named above, whose contact information is located at the end of the informed consent. For questions concerning your rights as a research participant, contact Georgia Southern University Institutional Review Board at 912-478-5465 or irb@georgiasouthern.edu.

10. Voluntary Participation: Participation in the survey is voluntary. Participation may be ended at any time and all questions do not have to be answered. Final submission of the survey is voluntary as well.

11. Penalty: There is no penalty for deciding not to participate in the study; participants may decide at any time they don't want to participate further and may withdraw without penalty or retribution.

12. Participants must be 18 years of age or older to consent to participate in this research survey.

Upon request, you will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GS Institutional Review Board under tracking number: **H21201**.

Title of Project: Meeting the 21st Century Surveying-Geomatics Education Needs of GDOT and Georgia
Principal Investigator: Dr. David Scott, 912-478-6453, dscott@georgiasouthern.edu
Other Investigator(s): Dr. Gustavo Maldonado, 912-478-0016, gmaldonado@georgiasouthern.edu
Dr. Soonkie Nam, 912-478-2343, snam@georgiasouthern.edu,

Online version of survey:
Statement provided in Question 1 of the survey: Based on your completion and submission of this first question of the survey and your submission of the survey itself, you are giving your consent for project researchers to utilize the information that you provide for research purposes for the improvement of Surveying-Geomatics Education in the State of Georgia. Your identity will remain anonymous throughout the research process.

Paper version of survey:
Statement provided in Question 1 of the survey: Based on your completion and submission of this first question of the survey and your submission of the survey itself, you are giving your consent for project researchers to utilize the information that you provide for research purposes for the improvement of Surveying-Geomatics Education in the State of Georgia. Your identity will remain anonymous throughout the research process.

APPENDIX J: SURVEY DOCUMENT

Survey on SURVEYING-GEOMATICS in GA

The purpose of this survey is to collect data to enhance the Land Surveying/Geomatics education and profession in Georgia, USA. The survey contains a total of 37 brief multiple- choice questions with 14 of them requiring a short-written answer in their parts b. All the questions are distributed in 4 sections. It may take 20 minutes to conscientiously answer allof them. Your responses are greatly appreciated by Georgia Southern University and the Georgia Department of Transportation.

SECTION 1 of 4: Participant's characteristics

Section 1 contains five questions.

[1-01] What is your level of education?
(Based on your completion and submission of this first question of the survey and your submission of the survey itself, you are giving your consent for project researchers to utilize the information that you provide for research purposes for the improvement of Surveying-Geomatics Education in the State of Georgia. Youridentity will remain anonymous throughout the research process.) Mark only one oval. *MARK ONLY ONE OVAL*.

- ◯ Non-traditional pathway
- ◯ Bachelor's Degree
- ◯ Master's degree
- ◯ Doctoral degree
- ◯ Other

[1-02] Do you specialize in any one area of Surveying-Geomatics? (I.e., Terrestrial Surveying or GPS Surveying or GIS or Mapping, etc.). *MARK ONLY ONE OVAL*.

- ◯ Yes
- ◯ No

[1-03] Are you employed by a public entity? (Federal, State or Local Government/Agency). *MARK ONLY ONE OVAL*.

- ◯ Yes
- ◯ No

[1-04] Are you a licensed Professional Land Surveyor in the State of Georgia? *MARK ONLY ONE OVAL*.

- ◯ Yes
- ◯ No

[1-05] To estimate the economic impact of surveying in Georgia, the following ranges of annual salary are given. Please indicate your current range. *MARK ONLY ONE OVAL*.

- $20K - $39K
- $40K - $59K
- $60K - $79K
- $80K - $99K
- $100K and over

Section 2 of 4: Surveying-Geomatics Body of Knowledge

This section contains 10 questions

[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th	5th
Measurements					
Data Analysis and Management					
Adjustments					
Coordinate Geometry					
Information Extraction					

[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). *PLEASE, SELECT ONLY ONE OPTION PERROW AND PER COLUMN*.

	1st	2nd	3rd	4th	5th
Measurements					
Data Analysis and Management					
Adjustments					
Coordinate Geometry					
Information Extraction					

[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). *PLEASE, SELECT ONLY ONE OPTION PER COLUMN*.

	1st	2nd	3rd	4th	5th
Conceptual Foundations					
Data Modeling					
Design Aspects					
Geospatial Data					
Data Manipulation					
Analytical Methods					
Cartography and Visualizations					
Legal and Ethical Aspects of GIS					
Management and Organization Aspects					

[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? *PLEASE, SELECT ONLY ONE OPTION PER COLUMN*.

	Weakest	Extremely Weak	Very Weak	Moderately Weak	Weak
Conceptual Foundations					
Data Modeling					
Design Aspects					
Geospatial Data					
Data Manipulation					
Analytical Methods					
Cartography and Visualizations					
Legal and Ethical Aspects of GIS					
Management and Organization Aspects					

[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). *PLEASE, SELECT ONLY ONE OPTION PER COLUMN*.

	1st	2nd	3rd	4th	5th
Cameras and Photography	◯	◯	◯	◯	◯
Radiometry, Detection and Sensing	◯	◯	◯	◯	◯
Frame Geometry	◯	◯	◯	◯	◯
Imaging Measurements	◯	◯	◯	◯	◯
Stereoscopy and Parallax	◯	◯	◯	◯	◯
Mathematical Modeling and Analytical Photogrammetry	◯	◯	◯	◯	◯
Computer Vision	◯	◯	◯	◯	◯
Estimation, Adjustment, Statistics, and Error Propagation	◯	◯	◯	◯	◯
Stereo Restitution	◯	◯	◯	◯	◯
Rectification and Resampling	◯	◯	◯	◯	◯
Mapping and Cartography	◯	◯	◯	◯	◯
Topography and Digital Elevation Modeling	◯	◯	◯	◯	◯
Digital Photogrammetry	◯	◯	◯	◯	◯
Project Planning	◯	◯	◯	◯	◯
Close-Range Photogrammetry	◯	◯	◯	◯	◯
Satellite Photogrammetry	◯	◯	◯	◯	◯
Remote Sensing	◯	◯	◯	◯	◯
Active Sensing with LiDAR	◯	◯	◯	◯	◯
Applications	◯	◯	◯	◯	◯

[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? *PLEASE, SELECT ONLY ONE OPTION PER COLUMN*.

	Weakest	Extremely Weak	Very Weak	Moderately Weak	Weak
Cameras and Photography	⬭	⬭	⬭	⬭	⬭
Radiometry, Detection and Sensing	⬭	⬭	⬭	⬭	⬭
Frame Geometry	⬭	⬭	⬭	⬭	⬭
Imaging Measurements	⬭	⬭	⬭	⬭	⬭
Stereoscopy and Parallax	⬭	⬭	⬭	⬭	⬭
Mathematical Modeling and Analytical Photogrammetry	⬭	⬭	⬭	⬭	⬭
Computer Vision	⬭	⬭	⬭	⬭	⬭
Estimation, Adjustment, Statistics, and Error Propagation	⬭	⬭	⬭	⬭	⬭
Stereo Restitution	⬭	⬭	⬭	⬭	⬭
Rectification and Resampling	⬭	⬭	⬭	⬭	⬭
Mapping and Cartography	⬭	⬭	⬭	⬭	⬭
Topography and Digital Elevation Modeling	⬭	⬭	⬭	⬭	⬭
Digital Photogrammetry	⬭	⬭	⬭	⬭	⬭
Project Planning	⬭	⬭	⬭	⬭	⬭
Close-Range Photogrammetry	⬭	⬭	⬭	⬭	⬭
Satellite Photogrammetry	⬭	⬭	⬭	⬭	⬭
Remote Sensing	⬭	⬭	⬭	⬭	⬭
Active Sensing with LiDAR	⬭	⬭	⬭	⬭	⬭
Applications	⬭	⬭	⬭	⬭	⬭

[2-07] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th
Communication Skills	◯	◯	◯	◯
Site Design and Resource Management	◯	◯	◯	◯
Site Constraints	◯	◯	◯	◯
Project Administration, Management and Organization	◯	◯	◯	◯

[2-08] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? *PLEASE, SELECT ONLY ONE OPTION PER ROW*.

	Very Strong	Strong	Weak	Very Weak
Communication Skills	◯	◯	◯	◯
Site Design and Resource Management	◯	◯	◯	◯
Site Constraints	◯	◯	◯	◯
Project Administration, Management and Organization	◯	◯	◯	◯

[2-09] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd
Legal Systems	⬭	⬭	⬭
Legal Resources	⬭	⬭	⬭
Law and Business	⬭	⬭	⬭

[2-10] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	Strong	Normal	Weak
Legal Systems	⬭	⬭	⬭
Legal Resources	⬭	⬭	⬭
Law and Business	⬭	⬭	⬭

Section 3 of 4:
Surveying-GeomaticsJob Positions Matrix Analysis

This section contains ten questions. Three of them have two parts (a and b)

[3-01a] From this analysis, the Bachelor of Science (BS) degree is the most prominent requirement for most surveying-geomatics job positions. Do you think the BS requirement represents the minimum qualification of Land Surveyors in Georgia in the 21st century? *MARK ONLY ONE OVAL*.

⬭ Yes

⬭ No

⬭ Maybe

[3-01b] Please, briefly elaborate on your selected answer to the previous question[3-01a] or write "No comment".

[3-02] GDOT created the following Surveying-Geomatics job positions: "Location Bureau Chief", "Engineering Operations Manager", "Assistant Consultant Compliance Supervisor", "Consultant Compliance Supervisor", "Quality AssuranceSupervisor", "Statewide Cadastral Supervisor", "Statewide Geodetic Supervisor", "Statewide Survey data Specialist", "Assistant Statewide Survey Data Specialist", "Surveying Technician 2", "Surveying Technician 1", "Computations Technician", "Survey Party Chief", and "Assistant Survey Party Chief". Do you think those positions can be used as a tool to analyze surveying-geomatics positions availability in Southeastern United States?
MARK ONLY ONE OVAL.

- Yes
- No
- I do not know

[3-03] From this analysis, there is no detectable correlation between the surveying-geomatics job positions available and the number of new surveying graduates. Do you think the number of available surveying jobs is adequate for the number of yearly surveying graduates?
MARK ONLY ONE OVAL.

- Yes
- No
- I do not know

[3-04] From this analysis, Professional Land Surveying licensure appears to be avery important requirement. Do you think having licensure improves the performance of surveyors on the job?
MARK ONLY ONE OVAL.

- Yes
- No
- I do not know

[3-05] From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Please, rank these groups in order of importance (where 1st = Most Important Group). *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th
GIS	◯	◯	◯	◯
Remote Sensing	◯	◯	◯	◯
LiDAR	◯	◯	◯	◯
Others	◯	◯	◯	◯

[3-06a] From our current research, it is noted that students should be exposed to geospatial applications while in school to better prepare them for job opportunities upon graduation. Some of the means identified to accomplish this are listed below. PLEASE, SELECT ALL ANSWERS THAT ARE APPROPRIATE.

- ☐ (a) Including more geospatial courses in the curriculum
- ☐ (b) Modifying/improving existing courses
- ☐ (c) Other

[3-06b]: Please, briefly elaborate on your selected item(s) in the previous question [3-06a] or write "No comment".

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[3-07a] Based on this analysis, the largest number of available positions in Surveying-Geomatics are in field operations. Do you think that most new Surveying-Geomatics jobs require mostly field work? *MARK ONLY ONE OVAL*.

- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Indifferent

[3-07b] Please, briefly elaborate on your selected answer to the previous question [3-07a] or write "No comment".

[3-08] From this analysis, most of the new Surveying-Geomatics jobs reviewed require no in-house experience. Do you think this lack of in-house experience will impact the new employee's performance on the job? *MARK ONLY ONE OVAL*.

- Yes
- No
- I do not know

[3-09] Many of the Surveying-Geomatics jobs require some number of years of prior experience. Do you think hiring should be based on the number of years of experience of the new employee? MARK ONLY ONE OVAL.

- Yes
- No
- I do not know

[3-10] From this analysis, it is seen that the annual salary for Surveying-Geomatics jobs ranges from $22k to $116k. In general, do you think that these salaries are large enough considering responsibility, education, and experience requirements for modern Surveying-Geomatics positions? *MARK ONLY ONE OVAL*.

- Yes
- No
- 9

Section 4 of 4: Georgia Surveying-Geomatics Education/Subject Coverage Matrix Analysis

[4-01a] Please, rank the below pathways from best to worst regarding your perception on their adequacy/sufficiency to prepare students for the FS/PS exam? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN.

	Best	Normal	Worst
Completion of Certificate			
Completion of BS			
Non-traditional learning			

[4-01b] Please, briefly elaborate on your answers to the previous question [4-01a]. If you think those are not adequate pathways, please describe below your desired course of study or write “No comment”.

[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. *PLEASE, SELECT ONLY ONE OPTION PER ROW*.

	Yes	Maybe	No
Is the knowledge about the instrument(s) good?			
Is the knowledge about land surveying law good?			
Is the knowledge of professional practice good?			
Are the communication skills good?			
Is the knowledge of professional ethics good?			
Is the knowledge about GIS good?			
Is the knowledge about Photogrammetry and Drones good?			
Is the knowledge about LiDAR good?			

[4-02b] Consider the previous question [4-02a] and briefly provide your opinion(s) or write "No comment".

[4-03a] The Georgia Board of Registration considers five levels of Surveying- Geomatics courses: S1=Foundations in Surveying; S2=Advanced Surveying; S3=Legal Aspects; S4=Professional Practice; and S5+=Additional Courses (i.e., GIS, LiDAR, Photogrammetry courses). Please, indicate your perception on how these course levels support the requirements of advanced technologies in the S-G field. *PLEASE, SELECT ALL ANSWERS THAT ARE APPROPRIATE*.

- ☐ Courses only cover the fundamentals of surveying
- ☐ Courses cover limited technologies supporting only a handful of instruments in the industry
- ☐ Courses create the background for advanced technologies
- ☐ Courses cover all the advanced technologies

[4-03b] Consider the previous question [4-03a]. If you have a different opinion, please briefly describe it, or write "No comment".

[4-04a] Georgia has four Surveying-Geomatics educational institutions, i.e., Albany Technical College (ATC), Georgia Southern University (GA Southern), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please, indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia? *PLEASE, SELECT ONLY ONE OPTION PER ROW*.

	Number of graduates surpasses the requirements.	Number of graduates barely meets the requirements.	Number of graduates are less than the requirements.	I do not know
ATC	◯	◯	◯	◯
GA Southern	◯	◯	◯	◯
KSU	◯	◯	◯	◯
UNG	◯	◯	◯	◯

[4-04b] Consider the previous question [4-04a]. If you have a different opinion, please briefly describe it or write "No comment".

[4-05a] Do you think the Surveying-Geomatics educational institutions in Georgia can provide the required knowledge for the 21st century? *PLEASE, SELECT ONLY ONE OPTION PER ROW*.

	The institution has all the advanced lab instruments/facilities and sufficient professional instructors to support the technologies.	The institution have limited lab instruments and few professional instructors providing fundamental learning only.	The institutions have limited lab instruments but sufficient professional instructors.	The institutions have advanced lab instruments but lack professional instructors.	I do not know
ATC					
GA Southern					
KSU					
UNG					

[4-05b] Consider the previous question [4-05a]. If you have a different opinion, please briefly describe it, or write "No comment".

[4-06a] Do you think the Surveying-Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs?
PLEASE, SELECT ONLY ONE OPTION PER ROW.

	Students are learning all the required professional knowledge from the instructors.	Students are learning specific problems only but cannot accommodate the changes in situation.	Students cannot apply their knowledge in the field at all.	I do not know
ATC	⬭	⬭	⬭	⬭
GA Southern	⬭	⬭	⬭	⬭
KSU	⬭	⬭	⬭	⬭
UNG	⬭	⬭	⬭	⬭

[4-06b] Consider the previous question [4-06a]. If you have a different opinion,please briefly describe it, or write "No comment".

[4-07] Given the following options, please select what you think is the most effective method of class presentation for student learning? *PLEASE, SELECT ONLY ONE OPTION PER ROW*.

	Face-to-face	Online	Hybrid	I do not know
Acquisition/Assimilation of knowledge	⬭	⬭	⬭	⬭
Knowledge sharing and problem-based learning	⬭	⬭	⬭	⬭
Time flexibility	⬭	⬭	⬭	⬭
Presentation	⬭	⬭	⬭	⬭

[4-08a] Considering face-to-face, online, and hybrid class course presentation methods, which one is the most suitable for Surveying-Geomatics courses? *MARK ONLY ONE OVAL*.

- Face-to-face class is more suitable because students have more interaction with the instructors and can operate surveying instruments with hands.
- Online class is more suitable because students can learn from a distant place and have the flexibility of time.
- Hybrid class is more suitable because students can learn from a distance and when required they can interact with the instructor face-to-face and operate instruments with their own hands.

[4-08b] Consider the previous question [4-08a]. If you have a different opinion, please briefly describe, it or write "No comment".

[4-09a] Please, compare and rank (from 1st = Maximum to 4th = Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to their availability of S-G courses. *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th
ATC				
GA Southern				
KSU				
UNG				

[4-09b] Consider the previous question [4-09a]. Please, briefly provide a reason for the 1st and 4th rank or write "No comment".

[4-10a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the S-G skills of their graduates. *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th
ATC	⬭	⬭	⬭	⬭
GA Southern	⬭	⬭	⬭	⬭
KSU	⬭	⬭	⬭	⬭
UNG	⬭	⬭	⬭	⬭

[4-10b] Consider the previous question [4-10a]. Please, briefly provide a reasonfor the 1st and 4th rank or write "No comment".

[4-11a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the academic qualifications and experience of S-G subject instructors. *PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN*.

	1st	2nd	3rd	4th
ATC	⬭	⬭	⬭	⬭
GA Southern	⬭	⬭	⬭	⬭
KSU	⬭	⬭	⬭	⬭
UNG	⬭	⬭	⬭	⬭

[4-11b] Consider the previous question [4-11a]. Please, briefly provide a reason for the 1st and 4th rank or write "No comment".

[4-12a] This survey is almost done. Please, rate the quality of this survey by selecting one of the below grades: *MAKR ONLY ONE OVAL*.

- (5) Excellent
- (4) Good
- (3) Neutral
- (2) Poor
- (1) Very Poor

[4-12b] Please, briefly elaborate on your selected ranking from the previous question [4-12a] or write "No Comment". THIS IS THE LAST QUESTION. Thank you so much for your time and answers.

APPENDIX K: RAW RESULTS

[1-01] – [1-05]

Timestamp	[1-01] What is your level of education? ——————————————- (Based on your completion and submission of this first question of the survey and your submission of the survey itself, you are giving your consent for project researchers to utilize the information that you provide for research purposes for the improvement of Surveying-Geomatics Education in the State of Georgia. Your identity will remain anonymous throughout the research process.)	[1-02] Do you specialize in any one area of Surveying-Geomatics? (I.e., Terrestrial Surveying or GPS Surveying or GIS or Mapping, etc.)	[1-03] Are you employed by a public entity? (Federal, State or Local Government/Agency)	[1-04] Are you a licensed Professional Land Surveyor in the State of Georgia?	[1-05] To estimate the economic impact of surveying in Georgia, the following ranges of annual salary are given. Please indicate your current range.

[1-01] – [1-05] Cont'd.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Number of Timestamps 82	Non-traditional pathway 17	Yes 33	Yes 16	Yes 61	$20K - $39K 5
Blank 1	Bachelor's degree 42	No 48	No 65	No 19	$40K - $59K 8
Total Attempts 83	Master's degree 12	Total Answers 81	Total Answers 81	Total Answers 80	$60K - $79K 19
	Doctoral degree 1	Corroboration of Total 81	Corroboration of Total 81	Corroboration of Total 80	$80K - $99K 13
	Other 9				$100K and over 37
	Total Answers 81				Total Answers 82
	Corroboration of Total 81				Corroboration of Total 82

[2-01]

[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Measurements]	[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Data Analysis and Management]	[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Adjustments]	[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Coordinate Geometry]	[2-01] Consider the following five (5) subareas of the TERRESTRIAL- and SATELLITE-BASED POSITIONING CATEGORY. What order would you rank these subareas in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Information Extraction]
Column 7	**Column 8**	**Column 9**	**Column 10**	**Column 11**
1st	1st	1st	1st	1st
40	30	2	2	6
2nd	2nd	2nd	2nd	2nd
18	26	13	15	7
3rd	3rd	3rd	3rd	3rd
13	13	22	17	15
4th	4th	4th	4th	4th
6	7	25	32	8
5th	5th	5th	5th	5th
2	4	16	12	43
Total Answers	Total Answers	Total Answers	Total Answers	Total Answers
79	80	78	78	79
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
79	80	78	78	79

[2-02]

[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Measurement]	[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Data Analysis and Management]	[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Adjustments]	[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Coordinate Geometry]	[2-02] Based on your personal experience in Surveying-Geomatics, given the five (5) subareas within the TERRESTRIAL- and SATELLITE-BASED POSITIONING category, what order would you rank these subareas in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? (With 1st = Strongest). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Information Extraction]
Column 12	**Column 13**	**Column 14**	**Column 15**	**Column 16**
1st 41	1st 23	1st 2	1st 5	1st 6
2nd 11	2nd 19	2nd 12	2nd 18	2nd 17
3rd 10	3rd 10	3rd 26	3rd 20	3rd 11
4th 10	4th 16	4th 18	4th 21	4th 12
5th 6	5th 10	5th 18	5th 10	5th 30
Total Answers 78	Total Answers 78	Total Answers 76	Total Answers 74	Total Answers 76
Corroboration of Total 78	Corroboration of Total 78	Corroboration of Total 76	Corroboration of Total 74	Corroboration of Total 76

[2-03]

[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Conceptual Foundations]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Data Modeling]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Design Aspects]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Geospatial Data]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Data Manipulation]
Column 17	Column 18	Column 19	Column 20	Column 21
1st	1st	1st	1st	1st
12	3	3	17	7
2nd	2nd	2nd	2nd	2nd
6	9	5	13	9
3rd	3rd	3rd	3rd	3rd
8	11	5	13	9
4th	4th	4th	4th	4th
4	12	9	6	13
5th	5th	5th	5th	5th
6	10	10	6	11
Total Answers	Total Answers	Total Answers	Total Answers	Total Answers
36	45	32	55	49
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
36	45	32	55	49

[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Analytical Methods]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Cartography and Visualizations]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Legal and Ethical Aspects of GIS]	[2-03] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance) PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Management and Organization Aspects]
Column 22	**Column 23**	**Column 24**	**Column 25**
1st	1st	1st	1st
7	7	7	13
2nd	2nd	2nd	2nd
13	6	6	8
3rd	3rd	3rd	3rd
9	4	9	8
4th	4th	4th	4th
13	5	3	9
5th	5th	5th	5th
7	8	3	12
Total Answers	Total Answers	Total Answers	Total Answers
49	30	28	50
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
49	30	28	50

[2-04]

[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Conceptual Foundations]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Data Modeling]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Desing Aspects]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Geospatial Data]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Data Manipulation]
Column 26	**Column 27**	**Column 28**	**Column 29**	**Column 30**
Weakest 12	Weakest 8	Weakest 4	Weakest 2	Weakest 5
Extremely Weak 8	Extremely Weak 8	Extremely Weak 11	Extremely Weak 2	Extremely Weak 12
Very Weak 6	Very Weak 5	Very Weak 8	Very Weak 5	Very Weak 15
Moderately Weak 4	Moderately Weak 9	Moderately Weak 16	Moderately Weak 8	Moderately Weak 4
Weak 12	Weak 9	Weak 3	Weak 6	Weak 9
Total Answers 42	Total Answers 39	Total Answers 42	Total Answers 23	Total Answers 45
Corroboration of Total 42	Corroboration of Total 39	Corroboration of Total 42	Corroboration of Total 23	Corroboration of Total 45

[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Analytical Methods]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Cartography and Visualizations]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Legal and Ethical Aspects of GIS]	[2-04] Given the below nine (9) subareas of the GEOSPATIAL SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Management and Organization Aspects]
Column 31	**Column 32**	**Column 33**	**Column 34**
Weakest 11	Weakest 4	Weakest 11	Weakest 16
Extremely Weak 8	Extremely Weak 6	Extremely Weak 7	Extremely Weak 12
Very Weak 12	Very Weak 6	Very Weak 7	Very Weak 9
Moderately Weak 11	Moderately Weak 8	Moderately Weak 2	Moderately Weak 9
Weak 10	Weak 6	Weak 11	Weak 6
Total Answers 52	Total Answers 30	Total Answers 38	Total Answers 52
Corroboration of Total 52	Corroboration of Total 30	Corroboration of Total 38	Corroboration of Total 52

[2-05]

[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Cameras and Photography]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Radiometry, Detection and Sensing]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Frame Geometry]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Imaging Measurements]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Stereoscopy and Parallax]
Column 35	Column 36	Column 37	Column 38	Column 39
1st	1st	1st	1st	1st
8	0	0	4	0
2nd	2nd	2nd	2nd	2nd
1	2	0	2	0
3rd	3rd	3rd	3rd	3rd
1	0	1	6	1
4th	4th	4th	4th	4th
4	0	0	5	0
5th	5th	5th	5th	5th
2	0	0	5	0
Total Answers	Total Answers	Total Answers	Total Answers	Total Answers
16	2	1	22	1
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
16	2	1	22	1

[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Mathematical Modeling and Analytical Photogrammetry]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Computer Vision]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Estimation, Adjustment, Statistics, and Error Propagation]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Stereo Restitution]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Rectification and Resampling]
Column 40	**Column 41**	**Column 42**	**Column 43**	**Column 44**
1st	1st	1st	1st	1st
5	0	6	0	0
2nd	2nd	2nd	2nd	2nd
3	5	6	1	0
3rd	3rd	3rd	3rd	3rd
3	0	5	0	2
4th	4th	4th	4th	4th
2	6	4	1	0
5th	5th	5th	5th	5th
3	4	6	0	1
Total Answers	Total Answers	Total Answers	Total Answers	Total Answers
16	15	27	2	3
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
16	15	27	2	3

[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Mapping and Cartography]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Topography and Digital Elevation Modeling]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Digital Photogrammetry]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Project Planning]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Close-Range Photogrammetry]
Column 45	Column 46	Column 47	Column 48	Column 49
1st	1st	1st	1st	1st
13	13	1	12	0
2nd	2nd	2nd	2nd	2nd
13	21	3	5	1
3rd	3rd	3rd	3rd	3rd
8	10	2	12	2
4th	4th	4th	4th	4th
2	6	8	7	3
5th	5th	5th	5th	5th
4	6	4	5	2
Total Answers	Total Answers	Total Answers	Total Answers	Total Answers
40	56	18	41	8
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
40	56	18	41	8

[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Satellite Photogrammetry]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Remote Sensing]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Active Sensing with LiDAR]	[2-05] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, what order would you rank the top five (5) of them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Applications]
Column 50	**Column 51**	**Column 52**	**Column 53**
1st	1st	1st	1st
0	3	4	3
2nd	2nd	2nd	2nd
1	2	4	1
3rd	3rd	3rd	3rd
5	5	6	0
4th	4th	4th	4th
4	3	8	5
5th	5th	5th	5th
3	2	10	10
Total Answers	Total Answers	Total Answers	Total Answers
13	15	32	19
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
13	15	32	19

[2-06]

[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Cameras and Photography]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Radiometry, Detection and Sensing]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Frame Geometry]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Imaging Measurements]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Stereoscopy and Parallax]
Column 54	**Column 55**	**Column 56**	**Column 57**	**Column 58**
Weakest 3	Weakest 2	Weakest 2	Weakest 4	Weakest 4
Extremely Weak 4	Extremely Weak 4	Extremely Weak 1	Extremely Weak 3	Extremely Weak 5
Very Weak 1	Very Weak 3	Very Weak 5	Very Weak 1	Very Weak 2
Moderately Weak 2	Moderately Weak 2	Moderately Weak 0	Moderately Weak 3	Moderately Weak 2
Weak 2	Weak 1	Weak 4	Weak 2	Weak 7
Total Answers 12	Total Answers 12	Total Answers 12	Total Answers 13	Total Answers 20
Corroboration of Total 12	Corroboration of Total 12	Corroboration of Total 12	Corroboration of Total 13	Corroboration of Total 20

[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Mathematical Modeling and Analytical Photogrammetry]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Computer Vision]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Estimation, Adjustment, Statistics, and Error Propagation]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Stereo Restitution]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Rectification and Resampling]
Column 59	**Column 60**	**Column 61**	**Column 62**	**Column 63**
Weakest 5	Weakest 2	Weakest 5	Weakest 4	Weakest 1
Extremely Weak 3	Extremely Weak 1	Extremely Weak 5	Extremely Weak 5	Extremely Weak 2
Very Weak 1	Very Weak 2	Very Weak 8	Very Weak 2	Very Weak 3
Moderately Weak 7	Moderately Weak 2	Moderately Weak 4	Moderately Weak 4	Moderately Weak 2
Weak 4	Weak 2	Weak 5	Weak 3	Weak 3
Total Answers 20	Total Answers 9	Total Answers 27	Total Answers 18	Total Answers 11
Corroboration of Total 20	Corroboration of Total 9	Corroboration of Total 27	Corroboration of Total 18	Corroboration of Total 11

[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Mapping and Cartography]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Topography and Digital Elevation Modeling]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Digital Photogrammetry]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Project Planning]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Close-Range Photogrammetry]
Column 64	**Column 65**	**Column 66**	**Column 67**	**Column 68**
Weakest 3	Weakest 2	Weakest 2	Weakest 9	Weakest 1
Extremely Weak 3	Extremely Weak 5	Extremely Weak 4	Extremely Weak 3	Extremely Weak 0
Very Weak 9	Very Weak 6	Very Weak 3	Very Weak 4	Very Weak 0
Moderately Weak 5	Moderately Weak 10	Moderately Weak 1	Moderately Weak 2	Moderately Weak 2
Weak 1	Weak 4	Weak 1	Weak 4	Weak 0
Total Answers 21	Total Answers 27	Total Answers 11	Total Answers 22	Total Answers 3
Corroboration of Total 21	Corroboration of Total 27	Corroboration of Total 11	Corroboration of Total 22	Corroboration of Total 3

[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Satellite Photogrammetry]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Remote Sensing]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Active Sensing with LiDAR]	[2-06] Given the below nineteen (19) subareas of the IMAGING SCIENCE CATEGORY, based on your personal experience in Surveying-Geomatics, what order would you rank the weakest top five (5) of them in terms of knowledge and skill of a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER COLUMN. [Applications]
Column 69	**Column 70**	**Column 71**	**Column 72**
Weakest 1	Weakest 2	Weakest 6	Weakest 2
Extremely Weak 1	Extremely Weak 1	Extremely Weak 5	Extremely Weak 6
Very Weak 4	Very Weak 2	Very Weak 1	Very Weak 3
Moderately Weak 0	Moderately Weak 1	Moderately Weak 6	Moderately Weak 3
Weak 0	Weak 6	Weak 5	Weak 3
Total Answers 6	Total Answers 12	Total Answers 23	Total Answers 17
Corroboration of Total 6	Corroboration of Total 12	Corroboration of Total 23	Corroboration of Total 17

[2-07]

[2-07] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Communication Skills]	[2-07] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Site Design and Resource Management]	[2-07] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Site Constraints]	[2-07] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Project Administration, Management and Organization]
Column 73	Column 74	Column 75	Column 76
1st	1st	1st	1st
45	6	6	19
2nd	2nd	2nd	2nd
22	18	9	30
3rd	3rd	3rd	3rd
6	30	28	13
4th	4th	4th	4th
5	24	32	15
Total Answers	Total Answers	Total Answers	Total Answers
78	78	75	77
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
78	78	75	77

[2-08]

[2-08] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Communication Skills]	[2-08] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Site Design and Resource Management]	[2-08] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Site Constraints]	[2-08] Given the below four (4) subareas of the LAND STEWARDSHIP CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Project Administration, Management and Organization]
Column 77	**Column 78**	**Column 79**	**Column 80**
Very Strong 27	Very Strong 17	Very Strong 10	Very Strong 14
Strong 9	Strong 19	Strong 27	Strong 14
Weak 21	Weak 29	Weak 19	Weak 17
Very Weak 18	Very Weak 8	Very Weak 18	Very Weak 28
Total Answers 75	Total Answers 73	Total Answers 74	Total Answers 73
Corroboration of Total 75	Corroboration of Total 73	Corroboration of Total 74	Corroboration of Total 73

[2-09]

[2-09] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Legal Systems]	[2-09] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Legal Resources]	[2-09] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, what order would you rank them in consideration of their importance to your daily operation within Surveying-Geomatics? (With 1st = Greatest Importance). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Law and Business]

Column 81	Column 82	Column 83
1st	1st	1st
18	22	41
2nd	2nd	2nd
28	38	13
3rd	3rd	3rd
33	20	26
Total Answers	Total Answers	Total Answers
79	80	80
Corroboration of Total	Corroboration of Total	Corroboration of Total
79	80	80

[2-10]

[2-10] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Legal Systems]	[2-10] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Legal Resources]	[2-10] Given the below three (3) subareas of the LEGAL ASPECTS CATEGORY, based on your personal experience on Surveying-Geomatics, what order would you rank them in terms of strongest to weakest for knowledge and skill for a newly licensed Land Surveyor in Training (LSIT) in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Law and Business]
Column 84	**Column 85**	**Column 86**
Strong 25	Strong 24	Strong 23
Normal 21	Normal 39	Normal 11
Weak 27	Weak 8	Weak 40
Total Answers 73	Total Answers 71	Total Answers 74
Corroboration of Total 73	Corroboration of Total 71	Corroboration of Total 74

[3-01] – [3-02]

[3-01a] From this analysis, the Bachelor of Science (BS) degree is the most prominent requirement for most surveying-geomatics job positions. Do you think the BS requirement represents the minimum qualification of Land Surveyors in Georgia in the 21st century?	[3-01b] Please, briefly elaborate on your selected answer to the previous question [3-01a] or write "No comment".	[3-02] GDOT created the following Surveying-Geomatics job positions: "Location Bureau Chief", "Engineering Operations Manager", "Assistant Consultant Compliance Supervisor", "Consultant Compliance Supervisor", "Quality Assurance Supervisor", "Statewide Cadastral Supervisor", "Statewide Geodetic Supervisor", "Statewide Survey data Specialist", "Assistant Statewide Survey Data Specialist", "Surveying Technician 2", "Surveying Technician 1", "Computations Technician", "Survey Party Chief", and "Assistant Survey Party Chief". Do you think those positions can be used as a tool to analyze surveying-geomatics positions availability in Southeastern United States?
Column 87	Column 88	Column 89
Yes	Number of written responses (including "No comment")	Yes
42	78	45
No	No comment (only)	No
24	11	15
Maybe	Number of elaborated responses	I do not know
16	67	21
Total Answers	Total Answers	Total Answers
82	78	81
Corroboration of Total	Corroboration of Total	Corroboration of Total
82	78	81

[3-03] – [3-04]

[3-03] From this analysis, there is no detectable correlation between the surveying-geomatics job positions available and the number of new surveying graduates. Do you think the number of available surveying jobs is adequate for the number of yearly surveying graduates?	[3-04] From this analysis, Professional Land Surveying licensure appears to be a very important requirement. Do you think having licensure improves the performance of surveyors on the job?
Column 90	**Column 91**
Yes	Yes
43	68
No	No
18	12
I do not know	I do not know
19	1
Total Answers	Total Answers
80	81
Corroboration of Total	Corroboration of Total
80	81

[3-05]

[3-05] From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Please, rank these groups in order of importance (where 1st = Most Important Group). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [GIS]	[3-05] From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Please, rank these groups in order of importance (where 1st = Most Important Group). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Remote Sensing]	[3-05] From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Please, rank these groups in order of importance (where 1st = Most Important Group). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [LiDAR]	[3-05] From this analysis, it was apparent the below software/geospatial skills groups are essential to employers when considering candidates to be hired. Please, rank these groups in order of importance (where 1st = Most Important Group). PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Others]
Column 92	Column 93	Column 94	Column 95
1st	1st	1st	1st
29	6	10	34
2nd	2nd	2nd	2nd
21	20	31	7
3rd	3rd	3rd	3rd
10	31	30	7
4th	4th	4th	4th
19	21	7	30
Total Answers 79	Total Answers 78	Total Answers 78	Total Answers 78
Corroboration of Total 79	Corroboration of Total 78	Corroboration of Total 78	Corroboration of Total 78

[3-06]

[3-06a] From our current research, it is noted that students should be exposed to geospatial applications while in school to better prepare them for job opportunities upon graduation. Some of the means identified to accomplish this are listed below. PLEASE, SELECT ALL ANSWERS THAT ARE APPROPRIATE.	[3-06b]: Please, briefly elaborate on your selected item(s) in the previous question [P3-06a] or write "No comment".

Column 96	Column 97
The options to check (one or more) are: (a) Including more geospatial courses in the curriculum (b) Modifying/improving existing courses (c) Other	Number of written responses (including "No comment") 76
	No comment (only) 26
(a) 19	Number of elaborated responses 50
(b) 22	Total Answers 76
(c) 11	Corroboration of Total 76
(a) + (b) 22	
(a) + (c) 0	
(b) + (c) 0	
(a) + (b) + (c) 5	
Total Answers 79	
Corroboration of Total 79	

[3-07]

[3-07a] Based on this analysis, the largest number of available positions in surveying-geomatics are in field operations. Do you think that most new surveying-geomatics jobs require mostly field work?	[3-07b] Please, briefly elaborate on your selected answer to the previous question [3-07a] or write "No comment".

Column 98	Column 99
Strongly agree	Number of written responses (including "No comment")
23	76
Agree	No comment (only)
32	22
Disagree	Number of elaborated responses
12	54
Strongly disagree	Total Answers
4	76
Indifferent	Corroboration of Total
11	76
Total Answers	
82	
Corroboration of Total	
82	

[3-08] – [3-10]

[3-08] From this analysis, most of the new surveying-geomatics jobs reviewed require no in-house experience. Do you think this lack of in-house experience will impact the new employee's performance on the job?	[3-09] Many of the surveying-geomatics jobs require some number of years of prior experience. Do you think hiring should be based on the number of years of experience of the new employee?	[3-10] From this analysis, it is seen that the annual salary for surveying-geomatics jobs ranges from $22k to $116k. In general, do you think that these salaries are large enough considering responsibility, education and experience requirements for modern surveying-geomatics positions?

Column 100	Column 101	Column 102
Yes 56	Yes 31	Yes 26
No 13	No 41	No 51
I do not know 10	I do not know 9	I do not know 4
Total Answers 79	Total Answers 81	Total Answers 81
Corroboration of Total 79	Corroboration of Total 81	Corroboration of Total 81

[4-01]

[4-01a] Please, rank the below pathways from best to worst regarding your perception on their adequacy/sufficiency to prepare students for the FS/PS exam? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Completion of Certificate]	[4-01a] Please, rank the below pathways from best to worst regarding your perception on their adequacy/sufficiency to prepare students for the FS/PS exam? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Completion of BS]	[4-01a] Please, rank the below pathways from best to worst regarding your perception on their adequacy/sufficiency to prepare students for the FS/PS exam? PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [Non-traditional learning]	[4-01b] Please, briefly elaborate on your answers to the previous question [4-01a]. If you think those are not adequate pathways, please describe below your desired course of study or write "No comment".
Column 103	Column 104	Column 105	Column 106
Best	Best	Best	Number of written responses (including "No comment")
16	54	11	77
Normal	Normal	Normal	No comment (only)
50	12	17	22
Worst	Worst	Worst	Number of elaborated responses
14	13	52	55
Total Answers	Total Answers	Total Answers	Total Answers
80	79	80	77
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
80	79	80	77

[4-02]

[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge about the instrument(s) good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge about land surveying law good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge of professional practice good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Are the communication skills good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge of professional ethics good?]
Column 107	**Column 108**	**Column 109**	**Column 110**	**Column 111**
Yes 47	Yes 37	Yes 34	Yes 34	Yes 39
Maybe 19	Maybe 24	Maybe 28	Maybe 26	Maybe 21
No 8	No 13	No 10	No 13	No 12
Total Answers 74	Total Answers 74	Total Answers 72	Total Answers 73	Total Answers 72
Corroboration of Total 74	Corroboration of Total 74	Corroboration of Total 72	Corroboration of Total 73	Corroboration of Total 72

[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge about GIS good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge about Photogrammetry and Drones good?]	[4-02a] Given your Surveying-Geomatics experience, select an answer for each of the below questions on the new S-G employee's performance in the professional field, at the current levels of educational background. PLEASE, SELECT ONLY ONE OPTION PER ROW. [Is the knowledge about LiDAR good?]	[4-02b] Consider the previous question [4-02a] and briefly provide your opinion(s) or write "No comment".
Column 112	**Column 113**	**Column 114**	**Column 115**
Yes 33	Yes 21	Yes 19	Number of written responses (including "No comment") 72
Maybe 30	Maybe 33	Maybe 36	No comment (only) 42
No 8	No 16	No 16	Number of elaborated responses 30
Total Answers 71	Total Answers 70	Total Answers 71	Total Answers 72
Corroboration of Total 71	Corroboration of Total 70	Corroboration of Total 71	Corroboration of Total 72

[4-03a]

[4-03a] The Georgia Board of Registration considers five levels of Surveying-Geomatics courses: S1=Foundations in Surveying; S2=Advanced Surveying; S3=Legal Aspects; S4=Professional Practice; and S5+=Additional Courses (i.e., GIS, LiDAR, Photogrammetry courses). Please, indicate your perception on how these course levels support the requirements of advanced technologies in the S-G field. PLEASE, SELECT ALL ANSWERS THAT ARE APPROPRIATE.

Column 116
The options to check (one or more) are: (a) Courses only cover the fundamentals of surveying (b) Courses cover limited technologies supporting only a handful of instruments in the industry (c) Courses create the background for advanced technologies (d) Courses cover all the advanced technologies

(a)
11

(b)
6

(c)
21

(d)
4

(a) + (b)
7

(a) + (c)
9

(a) + (d)
0

(b) + (c)
6

(b) + (d)
0

(c) + (d)
0

(a) + (b) + (c)
9

(a) + (b) + (d)
0

(a) + (c) + (d)
0

(b) + (c) + (d)
1

(a) + (b) + (c) + (d)
3

Total Answers
77

Corroboration of Total
77

[4-03b]

[4-03b] Consider the previous question [4-03a]. If you have a different opinion, please briefly describe it or write "No comment".

Column 117
Number of written responses (including "No comment")
71
No comment (only)
40
Number of elaborated responses
31
Total Answers
71
Corroboration of Total
71

[4-04]

[4-04a] Georgia has four Surveying-Geomatics educational institutions, i.e. Albany Technical College (ATC), Georgia Southern University (GA Southern), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please, indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [ATC]	[4-04a] Georgia has four Surveying-Geomatics educational institutions, i.e. Albany Technical College (ATC), Georgia Southern University (GA Southern), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please, indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [GA Southern]	[4-04a] Georgia has four Surveying-Geomatics educational institutions, i.e. Albany Technical College (ATC), Georgia Southern University (GA Southern), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please, indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [KSU]	[4-04a] Georgia has four Surveying-Geomatics educational institutions, i.e. Albany Technical College (ATC), Georgia Southern University (GA Southern), Kennesaw State University (KSU), and University of North Georgia (UNG). They support the S-G educational needs of the state as per the new Georgia Board of Registration policy (2018). Please, indicate your perception on the ability of these institutions to provide the required number of professional surveyors in Georgia? PLEASE, SELECT ONLY ONE OPTION PER ROW. [UNG]	[4-04b] Consider the previous question [4-04a]. If you have a different opinion, please briefly describe it or write "No comment".
Column 118	Column 119	Column 120	Column 121	Column 122
Number of graduates surpasses the requirements. 0	Number of graduates surpasses the requirements. 6	Number of graduates surpasses the requirements. 13	Number of graduates surpasses the requirements. 3	Number of written responses (including "No comment") 68
Number of graduates barely meets the requirements. 1	Number of graduates barely meets the requirements. 8	Number of graduates barely meets the requirements. 6	Number of graduates barely meets the requirements. 6	No comment (only) 38
Number of graduates are less than the requirements. 9	Number of graduates are less than the requirements. 13	Number of graduates are less than the requirements. 18	Number of graduates are less than the requirements. 14	Number of elaborated responses 30
I do not know 66	I do not know 50	I do not know 40	I do not know 53	Total Answers 68
Total Answers 76	Total Answers 77	Total Answers 77	Total Answers 76	Corroboration of Total 68
Corroboration of Total 76	Corroboration of Total 77	Corroboration of Total 77	Corroboration of Total 76	

[4-05]

[4-05a] Do you think the Surveying-Geomatics educational institutions in Georgia can provide the required knowledge for the 21st century? PLEASE, SELECT ONLY ONE OPTION PER ROW. [ATC]	[4-05a] Do you think the Surveying-Geomatics educational institutions in Georgia can provide the required knowledge for the 21st century? PLEASE, SELECT ONLY ONE OPTION PER ROW. [GA Southern]	[4-05a] Do you think the Surveying-Geomatics educational institutions in Georgia can provide the required knowledge for the 21st century? PLEASE, SELECT ONLY ONE OPTION PER ROW. [KSU]
Column 123	**Column 124**	**Column 125**
The institution has all the advanced lab instruments/facilities and sufficient professional instructors to support the technologies.	The institution has all the advanced lab instruments/facilities and sufficient professional instructors to support the technologies.	The institution has all the advanced lab instruments/facilities and sufficient professional instructors to support the technologies.
3	9	17
The institution have limited lab instruments and few professional instructors providing fundamental learning only.	The institution have limited lab instruments and few professional instructors providing fundamental learning only.	The institution have limited lab instruments and few professional instructors providing fundamental learning only.
4	9	8
The institutions have limited lab instruments but sufficient professional instructors.	The institutions have limited lab instruments but sufficient professional instructors.	The institutions have limited lab instruments but sufficient professional instructors.
4	4	3
The institutions have advanced lab instruments but lack professional instructors.	The institutions have advanced lab instruments but lack professional instructors.	The institutions have advanced lab instruments but lack professional instructors.
1	1	3
I do not know	I do not know	I do not know
63	55	45
Total Answers	Total Answers	Total Answers
75	78	76
Corroboration of Total	Corroboration of Total	Corroboration of Total
75	78	76

[4-05a] Do you think the Surveying-Geomatics educational institutions in Georgia can provide the required knowledge for the 21st century? PLEASE, SELECT ONLY ONE OPTION PER ROW. [UNG]	[4-05b] Consider the previous question [4-05a]. If you have a different opinion, please briefly describe it or write "No comment".

Column 126	Column 127
The institution has all the advanced lab instruments/facilities and sufficient professional instructors to support the technologies.	Number of written responses (including "No comment")
7	68
The institution have limited lab instruments and few professional instructors providing fundamental learning only.	No comment (only)
8	44
The institutions have limited lab instruments but sufficient professional instructors.	Number of elaborated responses
5	24
The institutions have advanced lab instruments but lack professional instructors.	Total Answers
3	68
I do not know	Corroboration of Total
52	68
Total Answers	
75	
Corroboration of Total	
75	

[4-06]

[4-06a] Do you think the Surveying-Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs? PLEASE, SELECT ONLY ONE OPTION PER ROW. [ATC]	[4-06a] Do you think the Surveying-Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs? PLEASE, SELECT ONLY ONE OPTION PER ROW. [GA Southern]	[4-06a] Do you think the Surveying-Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs? PLEASE, SELECT ONLY ONE OPTION PER ROW. [KSU]
Column 128	**Column 129**	**Column 130**
Students are learning all the required professional knowledge from the instructors. 3	Students are learning all the required professional knowledge from the instructors. 11	Students are learning all the required professional knowledge from the instructors. 18
Students are learning specific problems only but cannot accommodate the changes in situation. 4	Students are learning specific problems only but cannot accommodate the changes in situation. 9	Students are learning specific problems only but cannot accommodate the changes in situation. 11
Students cannot apply their knowledge in the field at all. 4	Students cannot apply their knowledge in the field at all. 3	Students cannot apply their knowledge in the field at all. 4
I do not know 64	I do not know 55	I do not know 43
Total Answers 75	Total Answers 78	Total Answers 76
Corroboration of Total 75	Corroboration of Total 78	Corroboration of Total 76

[4-06a] Do you think the Surveying-Geomatics instructional capabilities at the Georgia S-G educational institutions are meeting the professional needs? PLEASE, SELECT ONLY ONE OPTION PER ROW. [UNG]	[4-06b] Consider the previous question [P4-06a]. If you have a different opinion, please briefly describe it or write "No comment".

Column 131	Column 132
Students are learning all the required professional knowledge from the instructors. 8	Number of written responses (including "No comment") 66
Students are learning specific problems only but cannot accommodate the changes in situation. 6	No comment (only) 42
Students cannot apply their knowledge in the field at all. 4	Number of elaborated responses 24
I do not know 57	Total Answers 66
Total Answers 75	Corroboration of Total 66
Corroboration of Total 75	

[4-07]

[4-07] Given the following options, please select what you think is the most effective method of class presentation for student learning? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Acquisition/Assimilation of knowledge]	[4-07] Given the following options, please select what you think is the most effective method of class presentation for student learning? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Knowledge sharing and problem-based learning]	[4-07] Given the following options, please select what you think is the most effective method of class presentation for student learning? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Time flexibility]	[4-07] Given the following options, please select what you think is the most effective method of class presentation for student learning? PLEASE, SELECT ONLY ONE OPTION PER ROW. [Presentation]
Column 133	**Column 134**	**Column 135**	**Column 136**
Face-to-face	Face-to-face	Face-to-face	Face-to-face
34	37	12	34
Online	Online	Online	Online
10	12	34	10
Hybrid	Hybrid	Hybrid	Hybrid
28	25	27	28
I do not know	I do not know	I do not know	I do not know
8	5	6	7
Total Answers	Total Answers	Total Answers	Total Answers
80	79	79	79
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total
80	79	79	79

[4-08]

[4-08a] Considering face-to-face, online, and hybrid class course presentation methods, which one is the most suitable for surveying-geomatics courses?	[4-08b] Consider the previous question [4-08a]. If you have a different opinion, please briefly describe it or write "No comment".
Column 137	**Column 138**
Face-to-face class is more suitable because students have more interaction with the instructors and can operate surveying instruments with hands. 27	Number of written responses (including "No comment") 69
Online class is more suitable because students can learn from a distant place and have the flexibility of time. 10	No comment (only) 37
Hybrid class is more suitable because students can learn from a distance and when required they can interact with the instructor face-to-face and operate instruments with their own hands. 43	Number of elaborated responses 32
Total Answers 80	Total Answers 69
Corroboration of Total 80	Corroboration of Total 69

[4-09]

[4-09a] Please, compare and rank (from 1st = Maximum to 4th = Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to their availability of S-G courses. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [ATC]	[4-09a] Please, compare and rank (from 1st = Maximum to 4th = Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to their availability of S-G courses. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [GA Southern]	[4-09a] Please, compare and rank (from 1st = Maximum to 4th = Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to their availability of S-G courses. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [KSU]	[4-09a] Please, compare and rank (from 1st = Maximum to 4th = Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to their availability of S-G courses. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [UNG]	[4-09b] Consider the previous question [4-09a]. Please, briefly provide a reason for the 1st and 4th rank or write "No comment".
Column 139	Column 140	Column 141	Column 142	Column 143
1st	1st	1st	1st	Number of written responses (including "No comment")
1	12	32	4	68
2nd	2nd	2nd	2nd	No comment (only)
1	31	6	12	37
3rd	3rd	3rd	3rd	Number of elaborated responses
8	6	9	25	31
4th	4th	4th	4th	Total Answers
38	1	3	7	68
Total Answers	Total Answers	Total Answers	Total Answers	Corroboration of Total
48	50	50	48	68
Corroboration of Total	Corroboration of Total	Corroboration of Total	Corroboration of Total	
48	50	50	48	

[4-10]

[4-10a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the S-G skills of their graduates. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [ATC]	[4-10a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the S-G skills of their graduates. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [GA Southern]	[4-10a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the S-G skills of their graduates. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [KSU]	[4-10a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the S-G skills of their graduates. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [UNG]	[4-10b] Consider the previous question [4-10a]. Please, briefly provide a reason for the 1st and 4th rank or write "No comment".
Column 144	Column 145	Column 146	Column 147	Column 148
1st 1	1st 10	1st 33	1st 7	Number of written responses (including "No comment") 68
2nd 1	2nd 33	2nd 11	2nd 7	No comment (only) 34
3rd 6	3rd 8	3rd 7	3rd 27	Number of elaborated responses 34
4th 41	4th 0	4th 0	4th 7	Total Answers 68
Total Answers 49	Total Answers 51	Total Answers 51	Total Answers 48	Corroboration of Total 68
Corroboration of Total 49	Corroboration of Total 51	Corroboration of Total 51	Corroboration of Total 48	

[4-11]

[4-11a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the academic qualifications and experience of S-G subject instructors. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [ATC]	[4-11a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the academic qualifications and experience of S-G subject instructors. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [GA Southern]	[4-11a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the academic qualifications and experience of S-G subject instructors. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [KSU]	[4-11a] Please, compare and rank (from 1st=Maximum to 4th=Minimum) the four Surveying-Geomatics educational institutions in Georgia, according to the academic qualifications and experience of S-G subject instructors. PLEASE, SELECT ONLY ONE OPTION PER ROW AND PER COLUMN. [UNG]	[4-11b] Consider the previous question [4-11a]. Please, briefly provide a reason for the 1st and 4th rank or write "No comment".
Column 149	Column 150	Column 151	Column 152	Column 153
1st	1st	1st	1st	Number of written responses (including "No comment")
0	12	32	5	69
2nd	2nd	2nd	2nd	No comment (only)
1	30	9	7	41
3rd	3rd	3rd	3rd	Number of elaborated responses
8	4	6	27	28
4th	4th	4th	4th	Total Answers
38	0	1	7	69
Total Answers 47	Total Answers 46	Total Answers 48	Total Answers 46	Corroboration of Total 69
Corroboration of Total 47	Corroboration of Total 46	Corroboration of Total 48	Corroboration of Total 46	

[4-12]

[4-12a] This survey is almost done. Please, rate the quality of this survey by selecting one of the below grades:	[4-12b] Please, briefly elaborate on your selected ranking from the previous question [4-12a] or write "No Comment". THIS IS THE LAST QUESTION. Thank you so much for your time and answers.
Column 154	**Column 155**
(5) Excellent 11	Number of written responses (including "No comment") 73
(4) Good 32	No comment (only) 29
(3) Neutral 27	Number of elaborated responses 44
(2) Poor 9	Total Answers 73
(1) Very Poor 1	Corroboration of Total 73
Total Answers 80	
Corroboration of Total 80	

APPENDIX L: GSU S-G‑RELATED COURSE INFORMATION

Appendix L1: Course Flyers

L1-1 CENG 2231 Surveying

L1-2 CENG 5137/G Engineering Hydrology and Hydraulics

L1-3 CENG 5431/G Advanced Surveying

L1-4 CENG 5432/G Introduction to GIS in Surveying-Geomatics and Transportation

L1-5 CENG 5433/G Drainage and Erosion Control

L1-6 CENG 5434/G Surveying History and Law

L1-7 CENG 5435/G Introduction to LiDAR

L1-8 CENG 5436/G Introduction to Close Range Photogrammetry

L1-9 CENG 5438/G Surveying-Geomatics Professional Practice

L1-1: CENG 2231 Surveying

Surveying

Course Title: **CENG 2231**

Pre-requisites: A minimum grade of "C" in MATH 1112 or MATH 1113 or MATH 1441 and CENG 1133 or ENGR 1133 or TCM 1232.

Cross Listing (s): TCM 2233.

Course Description

Principles of the level, theodolite, electronic distance measurement EDM), total station and global positioning systems, taping, note keeping, coordinate geometry, control surveys, triangulation, trilateration, plane coordinate systems, azimuth and topographic mapping. Laboratory includes use of level, theodolite, EDM, total station, GPS, traverse closure, level net closure, topo-graphic mapping, measuring distances and heights using coordinate geometry calculations.

Credit Hours: 3

Course Schedule: TBA

Instructor: TBA

L1-2: CENG 5137/G Engineering Hydrology and Hydraulics

Engineering Hydrology and Hydraulics

Course Title: **CENG 5137/ CENG 5137G**

Pre-requisite (s): A minimum grade of "C" in CENG 2131 or permission of instructor.

Course Description

This course integrates concepts developed in Fluid Mechanics with fundamental hydrologic and hydraulic processes used in the analysis and design of urban drainage, flood control, and measurement structures. Hydrology topics include the hydrologic cycle, precipitation, hydrograph analysis, evapotranspiration, runoff, and flood routing. Hydraulics topics include open channel flow, hydraulic design, pump classification, pump and system curves, and water/wastewater pumping stations.

*(**CENG 5137G)** Graduate version requires a research component.*

Credit Hours:	3
Lecture Hours:	2
Lab Hours:	2
Instructor:	TBA
Class Schedule:	TBA

L1-3: CENG 5431/G Advanced Surveying

CENG 5431/G: Advanced Surveying: Summer 2021

Course Title: **CENG 5431/ CENG 5431G**

Pre-requisite (s): Departmental consent or a minimum grade of "C" in **CENG 2231 or TCM 2233.**

Instructor: Dr. Roger C. Purcell, Ph.D., P.E., R.L.S.
rcpurcell@georgiasouthern.edu 912-478-5001

Course Description

Principles of field astronomy, GPS surveys, control surveys, State Plane Coordinate Systems, photogrammetry, volume determination, route surveying (horizontal and vertical curvature) and an introduction to Geographical Information Systems. Laboratory* includes: GPS for control, coordinate system transformations, survey boundary development, topography survey, and roadway alignment.

(CENG 5431G) *Graduate version requires a research component.*

**PLS Lab Option Available*

Credit Hours: 3

Lecture Hours: 2

Lab Hours: 2

Topics:

Astronomic observations and calculations
Mapping Surveys
Control Surveys
Surveying Coordinate Systems
Boundary Surveys
Construction Surveys
Horizontal and Vertical Curves
Construction Volumes
Photogrammetry
Geographical information Systems

Class Schedule:
TBA

L1-4: CENG 5432/G Introduction to GIS in Surveying-Geomatics and Transportation

Introduction to GIS in Surveying-Geomatics and Transportation

Course Title: **CENG 5432/ CENG 5432G**

Pre-requisite (s): A minimum grade of "C" in CENG 2231 or TCM 2233 or department consent.

Course Description

An introduction to the knowledge and skill requirements of Geographic Information Systems (GIS) as applied to surveying-geomatics and transportation. Students will learn and apply GIS and cartographic concepts to develop problem solutions in surveying mapping & thematic mapping and to manipulate geo-referenced spatial information as required in typical industry applications.

(CENG 5432G) *Graduate version requires a research component.*

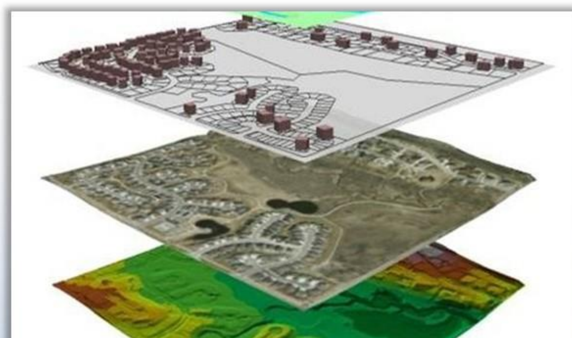
Credit Hours: 3

Lecture Hours: 2

Lab Hours: 2

Instructor: TBA

Class Schedule: TBA



L1-5: CENG 5433/G Drainage and Erosion Control

Drainage and Erosion Control

Course Title: **CENG 5433/ CENG 5433G**

Pre-requisite (s): A minimum grade of "C" in CENG 5137 or 5137G or departmental consent.

Course Description

Principles and practices of drainage design including drainage structures, storm-water quality and erosion & sediment control measures, with particular emphasis on governmental publications and regulations.

(CENG 5433G) *Graduate version requires a research component.*

Credit Hours: 3
Lecture Hours: 2
Lab Hours: 2
Instructor: TBA
Class Schedule: TBA

L1-6: 5434/G Surveying History and Law

Surveying History and Law

Course Title: **CENG 5434/ CENG 5434G**

Pre-requisite (s): Departmental Consent or a minimum grade of "C" in CENG 2231 or TCM 2233.

Course Description

Study of the legal aspects of surveying, including boundary law and the surveyor's rights and responsibilities, with particular emphasis on surveying practice in Georgia.

*(**CENG 5434G)** Graduate version requires a research component.*

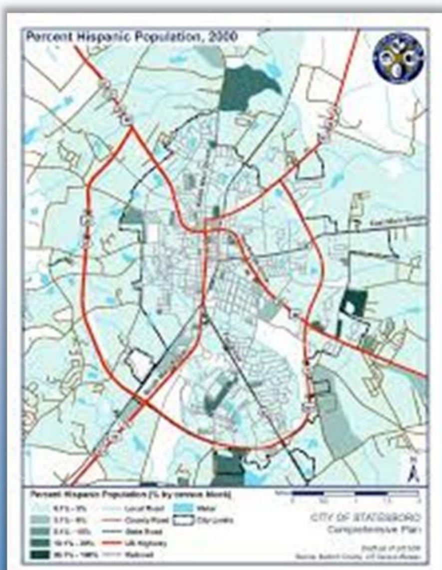
Credit Hours: 3

Lecture Hours: 2

Lab Hours: 2

Instructor: TBA

Class Schedule: TBA



L1-7: CENG 5435/G Introduction to LiDAR

Introduction to Terrestrial LiDAR

Course Number: **CENG 5435/ CENG 5435G**

Pre-requisite: Approval of the Instructor

Course Description

This course presents a thorough introduction to terrestrial light detection and ranging (LiDAR) or laser scanning and its multiple applications. It includes the use of selected state-of-the-art, ground-based, instruments and their corresponding data collection and processing software packages to generate 3D point-cloud models.

(CENG 5435G) *Graduate version requires a research component*

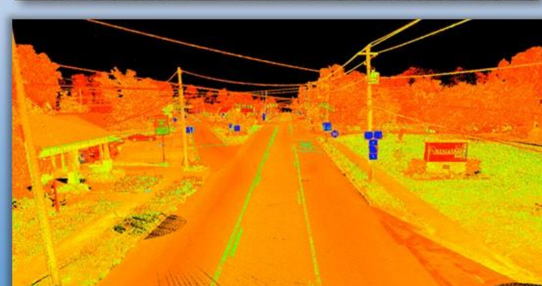
Credit Hours: 3

Lecture Hours: 2

Lab Hours: 2

Instructor: Dr. Gustavo Maldonado

Class Schedule: TBA



L1-8: CENG 5436/G Introduction to Close Range Photogrammetry

Introduction to Close-Range Photogrammetry

Course Title: **CENG 5436 / CENG 5436G**

Pre-requisite: Approval of the Instructor.

Course Description

This course presents a thorough introduction to close-range photogrammetry and its multiple applications in Civil and Construction Engineering. It includes the use of selected, state-of-the-art, unmanned aerial vehicles (UAVs) and associated data collection and processing software packages to generate 3D spatial models. Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

(CENG 5436G) *Graduate version requires a research component.*

Credit Hours:	3
Lecture Hours:	2
Lab Hours:	2
Instructor:	Dr. Gustavo Maldonado
Class Schedule:	TBA

L1-9: CENG 5438/G Surveying-Geomatics Professional Practice

Surveying-Geomatics Professional Practice

Course Title: **CENG 5438/ CENG 5438G**

Pre-requisites: A minimum grade of "C" in CENG 5431 and CENG 5434 or departmental consent.

Course Description

This course prepares the student for professional practice as a Land Surveyor and includes subdivision design, site layout including associated drainage and sewer design, application of zoning and land use regulations, professional ethics, associated business practices, platting and CAD/ computer methods.

(CENG 5438G) Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

Topics Covered

Land Development Overview
Review of typical planning & zoning, subdivision and development regulations
Review of Route Geometry as applied in subdivision design
Review of Earthwork Calculations as applied in subdivision design
Review of Storm Drainage as applied in subdivision design
Review of Sanitary Sewer design
Review of water supply layout and design
Erosion and Sediment Control
Development of Construction Plans for subdivision design
Subdivision Plans: Review and Approval process

Credit Hours: 3 hrs

Contact Hours/ Lecture/ Lab: 3 hrs./Lecture-Asynchronous

Contact: Name: Roger C. Purcell
Email: rcpurcell@georgiasouthern.edu
Phone: 912-478-5001

Effective Semester: Fall 2019

Appendix L2: Folio Course Cover Page

Appendix L3: Website

Civil Engineering & Construction

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Surveying-Geomatics Program Pathways (New)

At Georgia Southern University, you can use the following pathways to accomplish your Surveying-Geomatics goals. For place-bound students, our Surveying-Geomatics Courses (materials and quizzes) are available online with an option for required labs being facilitated by a Professional Land Surveyor (PLS Option).

The Non-Traditional Path (Required courses plus prerequisites)

This approach is best for the person who works during the day (preferably with a Surveying-Geomatics company). The non-traditional student may have some previous college coursework that may be considered for credit. Coursework under this path includes the necessary 18 semester credit hours currently required by the Georgia Board of Professional Engineers and Land Surveyors for the Land Surveyor Intern Certification (or Land Surveyor-in-Training).

For advising sheet, click here!

The following programs include Surveying-Geomatics embedded Certificates:

Bachelor of Science in Civil Engineering (BSCE) with Surveying-Geomatics: Advising Sheet

Bachelor of Science in Construction Engineering (BSConE) with Surveying-Geomatics: Advising Sheet

Bachelor of Science in Construction Management (BSCon) with Surveying-Geomatics: Advising Sheet

Traditional students typically obtain an embedded certificate through the above programs, all of which are offered in the Civil Engineering and Construction Department.

Master of Science in Civil Engineering (MSCE) with Surveying-Geomatics Specialization: Advising Sheet

The Master of Science in Civil Engineering (MSCE) degree program is a path for advanced students. The course group under this path includes the necessary 18 semester credit hours currently required by the Georgia Board of Professional Engineers and Land Surveyors for the Land Surveyor Intern Certification (or Land Surveyor-in-Training).

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Non-traditional adult and working students:

https://www.georgiasouthern.edu/working-professionals/

Traditional undergraduate civil Engineering, construction engineering and construction management students:

https://admissions.georgiasouthern.edu/requirements/freshmen/

Graduate civil engineering: MSCE or Accelerated Bachelor's Master's (ABM) Program

https://cogs.georgiasouthern.edu/admission/

Transfer students:

https://admissions.georgiasouthern.edu/requirements/transfer/

Program Contact:

Dr. Roger C. Purcell, P.E., R.L.S.
Department of Civil Engineering & Construction
Georgia Southern University
P.O. Box 8077
Statesboro, GA 30460-8077
Office: Engineering Bldg. 1101A
Phone: (912) 478-5001
rcpurcell@georgiasouthern.edu

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Georgia Southern University
P.O. Box 8077
Statesboro, GA 30460
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Fax: 912-478-1885
Email: cecm@georgiasouthern.edu

Physical Address
Engineering Building, Rm. 1120A
201 COBA Drive, BLDG 232
Statesboro, GA 30458

Career Opportunities

Surveying-Geomatics Career Opportunities

Surveyors are not likely to run out of things to do. Surveying has existed for thousands of years as a means to facilitate the location, construction, and cataloging of data. From the time of the ancient Egyptians to the modern day, surveyors have been the first on the job and the last to leave to make sure that things are located and constructed correctly.

There are a number of services that only a licensed Professional Surveyor can provide.

The location of property boundaries, and land-related services such as:

- Location
- Topography
- Spatial position
- Land use planning

Anything related to land location and use generally requires the services of a Professional Surveyor. Surveyors also collaborate with many other professionals, including engineers, architects, attorneys, realtors, developers, and contractors, and they advise land owners.

Land surveyors may have slightly different processes, depending on their specific type of surveying.

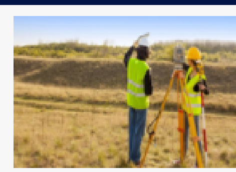
Construction or Engineering: This type of surveyor studies changes in property lines and identifies the precise locations of buildings and roads. They may also survey road topography and grade or determine the appropriate depth for building foundations.

Geodetic: A surveyor who uses satellite and aerial imaging to measure very large portions of the earth is called a geodetic surveyor.

Boundary or Land: This type of surveyor fulfills the important duty of determining exactly where property lines are located.

Contact Links for Career Opportunities:

- Surveying and Mapping Society of Georgia: Career Center
- National Society of Professional Surveyors: Career Center
- American Society of Civil Engineers: Career Connections
- Georgia Southern University Student Affairs: Career and Professional Development



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Frequently Asked Questions

Where can I find employment? Graduates can find employment just about anywhere they want to live. Logically, there will be more opportunities in the Atlanta area than in southwest Georgia. We hope that our graduates get jobs all over the United States, from Atlanta to California.

Can I get licensed as a surveyor? The program at Georgia Southern University is set up to support graduated students in obtaining surveyor's licenses in Georgia. Completing the necessary courses, obtaining the required experience (four to eight years depending on your education) and successfully passing two exams (Fundamentals of Surveying (FS) and Professional licensed Surveyor (PS) exams) leads to licensure as a Professional Land Surveyor (PLS). You can see the surveying exam applications and information at the National Council of Examiners for Engineering and Surveying (NCEES) website. https://ncees.org/surveying/

What types of jobs can I get after completing my surveying pathway at Georgia Southern University? Numerous jobs are available in the surveying-geomatics and geospatial fields depending on your education and background. The most common jobs are survey technician, survey party chief, survey project manager, computer aided design (CAD) technician, CAD manager, geographic information system (GIS) technician, GIS manager, photogrammetrist, geodesist, office manager and corporate officer. Jobs are available in the private sector and in the government sector at the local, state and federal agencies. If you are an entrepreneur at heart, setting up your surveying business is always an option after obtaining your surveying license.

What is the starting salary? Starting salaries depend on the position and the location of the employer. The Atlanta area probably has higher starting salaries. The starting salaries for licensed surveyors in Georgia can range from range from $45,000 to $90,000.

Where do graduates work? Graduates work across the United States. In Georgia, they work in small towns and large cities. Some work in small, family surveying companies. Others work in large multi-state surveying and mapping companies and civil engineering companies. Graduates can generally work where they desire, in any size firm they feel comfortable.

Is it difficult to get jobs? Like any profession, surveying employment depends on the location and the market or demand. There will be a demand for surveyors in Georgia in the future as the economy grows and the number of licensed surveyors declines due to retirement.

How difficult is it to find summer jobs? With a little effort, traditional students can obtain summer positions in the surveying or mapping fields. Career fairs at Georgia Southern University afford the student's opportunities to seek out internships and summer employment. We would like for our students to establish a relationship with a Surveying Company as soon as possible after their first year of college.

How do I fit in at Georgia Southern University? Georgia Southern University has almost 27,000 students and, for the traditional on-campus student, has comfortable dorms, a good research library, an event auditorium, numerous recreation opportunities, nationally recognized sports teams (e.g., NCAA football), tutoring for core classes, and a friendly atmosphere. The average class size in a surveying class size is 24 students or less. There are three faculty members with doctorates and one part-time faculty member that teach the Surveying-Geomatics courses.

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Contact Information

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Contact Your Future Advisor

Undergraduate Civil Engineering & Construction Engineering (Non-Traditional, BSCE)
Crystal Tisby
Statesboro Campus: IT 1208-I
(912) 478-6065
ctisby@georgiasouthern.edu

Undergraduate Construction Engineering (BSConE)
Stephanie White
Statesboro Campus: IT 1208-D
(912) 478-2530
slwhite@georgiasouthern.edu

Undergraduate Construction Management (Last Name A – I) (BSCon)
Chelsea Lanier
Statesboro Campus: IT 1208-K
(912) 478-0177
chayes@georgiasouthern.edu

Undergraduate Construction Management (Last Name J – Z) (BSCon)
Adam Post
Statesboro Campus: IT 1208-H
(912) 478-0453
apost@georgiasouthern.edu

Graduate Civil Engineering (MSCE or Accelerated Bachelor's to Master's Program: Civil Engineering)
Erica Colbert
Statesboro Campus: IT 3004
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ercolbert@georgiasouthern.edu

Meet Your Advisor: https://cec.georgiasouthern.edu/advisement/meet-your-advisor/

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Physical Address
Engineering Building, Rm. 1120A
201 COBA Drive, BLDG 232
Statesboro, GA 30458

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Instructors

Dr. Roger Purcell, P.E., R.L.S.
Program Coordinator
912-478-5001

Dr. Gustavo Maldonado, P.E., LEED AP
912-478-0016

Dr. Marcel Maghiar, CM-BIM
912-478-5833

Dr. Soonkie Nam
912-478-2343

Mr. Richard Hudson, P.E., G.I.S.P.

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Links of Interest

Surveying-Geomatics Links of Interest

Land Surveying

Surveying and Mapping Society of Georgia (SAMSOG)
National Society of Professional Surveyors (NSPS)
The American Association for Geodetic Surveying (AAGS)
National Geodetic Survey (NGS)
NGS Data Sheet Search
Federal Emergency Management Agency (FEMA)
State of Georgia Maps
RPLS Today

Education and Licensing

Georgia Southern University Department of Civil Engineering and Construction
University of North Georgia
Kennesaw State University – Southern Polytechnic School of Engineering and Engineering Technology
Georgia Institute of Technology
Georgia State Board of Registration for Engineers and Land Surveyors
National Council of Examiners for Engineering and Surveying (NCEES)
Georgia Geospatial Information Office (GIO)

Other Professional Organizations

American Society of Civil Engineers (ASCE)
Florida Surveying and Mapping Society
Alabama Society of Professional Surveyors (ASPLS)
Tennessee Association of Professional Surveyors (TAPS)
North Carolina Society of Surveyors

SAMSOG Sustaining Members

Allen Precision Equipment, Inc.
Construction Laser Inc.
Deaton's Geo-Tronics
Duncan-Parnell
Earl Dudley, Inc.
eGPS Solutions, Inc.
FLT Geosystems
Hayes Instrument Co.

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Surveying-Geomatics Scholarships

SAMSOG Education Foundation (SAMSEF)

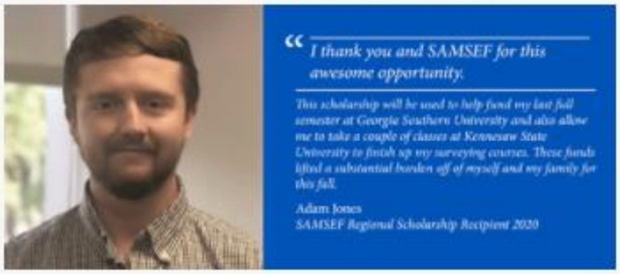
SAMSEF has three scholarship groups as follows:

Ben W. Fortson Scholarship

SAMSEF Regional Scholarships

SAMSEF Technical Scholarships

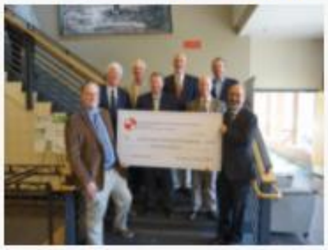
Go to: https://www.samsog.org/mpage/SAMSEF-Scholarship



National Society of Professional Surveyors (NSPS)

American Association for Geodetic Surveying Scholarships (AAGS)

Go to: https://www.nsps.us.com/page/Scholarships



Fall 2017

Fall 2018

Fall 2019

Georgia Southern University Receives funds for Surveying-Geomatics program development.

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- Surveying-Geomatics Course Flyers/Schedule
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- Advising
- Experiential Learning
- News

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Contact Information

Department of Civil Engineering and Construction
Georgia Southern University
P.O. Box 8077
Statesboro, GA 30460
Phone: 912-478-1894
Fax: 912-478-1885
Email: cecm@georgiasouthern.edu

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Surveying-Geomatics Courses

Surveying-Geomatics Course Flyers

- CENG 2231: Surveying
- CENG 5137/G: Engineering Hydrology and Hydraulics
- CENG 5431/G: Advanced Surveying
- CENG 5432/G: Introduction to GIS in Surveying-Geomatics and Transportation
- CENG 5433/G: Drainage and Erosion Control
- CENG 5434/G: Surveying History and Law
- CENG 5435/G: Introduction to Terrestrial LiDAR
- CENG 5436/G: Introduction to Close-Range Photogrammetry
- CENG 5438/G Surveying-Geomatics Professional Practice

Tentative Surveying-Geomatics Course Offering Schedule

Course Number & Name	Fall Semester	Spring Semester	Summer Semester	Comments
CENG 2231 Surveying (or TCM 2233 Construction Surveying)	X	X	X	TCM 2233 is not offered in the Summer.
CENG 5137/G Engineering Hydrology & Hydraulics			X	
CENG 5431/G Advanced Surveying			X	
CENG 5432/G Intro to GIS in Surveying-Geomatics & Transportation		X		
CENG 5433/G Drainage & Erosion Control	X			
CENG 5434/G Surveying History and Law		X		
CENG 5435/G Intro to Terrestrial LiDAR	X			
CENG 5436/G Intro to Close-Range Photogrammetry		X		
CENG 5438/G Surveying-Geomatics Professional Practice	X			

Appendix L4: Advising Sheets

Non-Traditional - LSIT Surveying Certification (18 Approved Surveying-Geomatics Semester Hours Required) Fall 2020**

Georgia Southern University
Allen E. Paulson College of Engineering and Computing
Department of Civil Engineering and Construction
Pathway for Georgia Surveying-Geomatics LSIT

Student Name: ____________________

Eagle ID: ____________________

Program Entry Date: ____________________

Completion of all requirements and a minimum of 2.0 GPA are required for graduation.

FALL 2020

1st Year		Prerequisite	Sem	Hrs	Gr
MATH 1111	College Algebra			3	
MATH 1112 or MATH 1113 or MATH 1441	Trigonometry, Pre-Calculus, Calculus I			3 (4)	
ENGR 1133/ CENG 1133	Eng. Graphics or CE Graphics			3	
CENG 2231 or TCM 2233	Surveying (w/option of PLS lab***) or Construction Surveying	MATH 1112 or MATH 1113 or MATH 1441 w/C, & ENGR 1133 or CENG 1133 or TCM 1232 w/C		3	

SPRING

		Prerequisite	Sem	Hrs	Gr
CENG 2231 or TCM 2233	Surveying (w/option of PLS lab***) or Construction Surveying	MATH 1112 or MATH 1113 or MATH 1441 w/C, & ENGR 1133 or CENG 1133 or TCM 1232 w/C		3	
CENG 5434	Surveying History & Law (Online)	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	

SUMMER

		Prerequisite	Sem	Hrs	Gr
CENG 2231	Surveying (w/option of PLS lab***)	MATH 1112 or MATH 1113 or MATH 1441 w/C, & ENGR 1133 or CENG 1133 or TCM 1232 w/C		3	
CENG 5431	Advanced Surveying (w/option of PLS lab ***)	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	

2nd Year		Prerequisite	Sem	Hrs	Gr
CENG 5435*	Intro to Terrestrial LiDAR (w/option of PLS lab***)	Approval of Instructor		3	
CENG 5438	Surveying-Geomatics Prof Practice (online)	CENG 5431 & CENG 5434 w/C		3	

		Prerequisite	Sem	Hrs	Gr
CENG 5432	GIS in Surv.-Geomatics/Transport (Online).	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	
CENG 5436*	Intro to Close-Range Photogrammetry (w/option of PLS lab***)	Permission of Instructor		3	

		Prerequisite	Sem	Hrs	Gr

***Must Choose from CENG 5435 or CENG 5436 in order to complete 18 Approved Surveying-Geomatics Semester credit hours.**
**** Program (CENG 2231) can start on any semester (or TCM 2233 can start in Fall or Spring semester) and generally at least one semester will require the completion of two (2) CENG Surveying-Geomatics courses.**
***** PLS Lab allows the student to perform the required course lab off-campus under the supervision of a Professional Land Surveyor. Lecture material and testing material provided online for all CENG Surveying-Geomatics courses.**

The required minimum passing grade for all CENG courses is a C.
The required minimum passing grade for all pre-requisite courses is a C.

BSCE: CIVIL ENGINEERING FOUR-YEAR PLAN INCLUDING EMBEDDED SURVEYING-GEOMATICS CERTIFICATE

Georgia Southern University
Allen E. Paulson College of Engineering and Information Technology
Department of Civil Engineering and Construction Management
Civil Engineering (CENG) Program

Student Name: ______________________

Eagle ID: ______________________

Program Entry Date: ______________________

Completion of all requirements and a minimum of 2.0 GPA are required for graduation.

1st Year

FALL

		Prerequisite	Sem	Hrs	Gr
ENGL 1101	Composition I			3	
HIST 2110 or 2111 or 2112	U.S. A Comprehensive Survey or History of the United States to 1877 or History of the United States Since 1877			3	
MATH 1441	Calculus I			4	
CENG 1133	CE Graphics			3	
FYE 1220	First Year Seminar			2	
				15	

SPRING

		Prerequisite	Sem	Hrs	Gr
ENGL 1102	Composition II	ENGL 1101 w/C		3	
PHYS 2211K	Principles of Physics I	MATH 1441 w/C		4	
MATH 2242	Calculus II	MATH 1441 w/C		4	
POLS 1101	American Government			3	
KINS 1525	Concepts of Health & Physical Activity			2	
				16	

SUMMER

		Prerequisite	Sem	Hrs	Gr
CENG 2231	Surveying	CENG 1133 w/C or ENGR 1133 w/C or TCM 1232 w/C & MATH 1112 or 1113 or 1441 w/C		3	
STAT 1401	Elementary Statistics	MATH 1112 or higher w/C		3	
				6	

2nd Year

		Prerequisite	Sem	Hrs	Gr
ENGR 2231	Engineering Mechanics I	MATH 2242 w/C, & PHYS 2211 w/C		3	
PHYS 2212K	Principles of Physics II	PHYS 2211K w/C		4	
MATH 2243	Calculus III	MATH 2242 w/C		4	
CENG 1731	Civil Engineering Computations	MATH 1441 w/C Co- or prereq.		3	
CENG 5435	Intro to Terrestrial LiDAR	Approval of Instructor		3	
				17	

		Prerequisite	Sem	Hrs	Gr
ENGR 3233	Mechanics of Materials	ENGR 2231 w/C		3	
CHEM 1310	Compreh. Gen'l Chem			4	
MATH 2160	Elem. Linear Algebra.	MATH 2242 w/C		3	
CENG 2131	CE Fluid Mechanics	ENGR 2231 w/C		3	
CENG 5432	Intro. to GIS in Surveying-Geomatics & Transportation	CENG 2231 w/C or TCM 2233 w/C, or permission of instructor		3	
CORE 2000	Core Capstone Course			1	
				17	

		Prerequisite	Sem	Hrs	Gr
CENG 5137	Engineering Hydrology and Hydraulics	CENG 2131 w/C or permission of instructor		3	
ECON 2105	Principles of Macroeconomics			3	
				6	

3rd Year

		Prerequisite	Sem	Hrs	Gr
CENG 3131	Intro to Env. Engineering	CHEM 1310 w/C		3	
CENG 3331	Structural Analysis	ENGR 3233 w/C		3	
CENG 3232	Soil Mechanics	ENGR 3233 w/C		3	
CENG 4135	Highway Design	CENG 2231 w/C or TCM 2233 w/C		3	
MATH 3230	Ord. Differential Equations	MATH 2242 w/C		3	
CENG 5433	Drainage & Erosion Control	CENG 5137 w/C or 5137G w/C or Dept. Consent		3	
				18	

		Prerequisite	Sem	Hrs	Gr
CENG 3132	Intro to Water & Wastewater Treatment	CENG 2131 w/C & CENG 3131 w/C		3	
CENG 3333	Reinforced Concrete Design	CENG 3331 w/C		3	
CENG 3233	Civil Engr'g Materials	ENGR 3233 w/C		3	
ENGR 2232	Dynamics of Rigid Bodies	ENGR 2231 w/C		3	
CENG 5434	Surveying History & Law	CENG 2231 w/C or TCM 2233 w/C or permission of instructor		3	
				15	

		Prerequisite	Sem	Hrs	Gr
CENG 5431	Advanced Surveying	CENG 2231 w/C or TCM 2233 w/C or permission of instructor		3	
	Area "C" Elective I[1]			3	
				6	

4th Year		Prerequisite	Sem	Hrs	Gr
CENG 3135	Construction Cost Control & Finance	ECON 2105 w/C		3	
CENG 4331	Structural Steel Design	CENG 3331 w/C		3	
CENG 4518	Intro to Senior Project	Sr. Stand & Co- or Prereq CENG 3333 w/C or 4331 w/C		1	
	Area "C" Elective II[2]	COMM 1110 Recommended		3	
	Area "D" Science[4]			4	
CENG 5438	Surveying-Geomatics Prof. Practice	CENG 5431 w/C and CENG 5434 w/C or permission of instructor		3	
				17	

		Prerequisite	Sem	Hrs	Gr
	Area "B" Elective	GEOG 1130 Recommended		3	
HIST 111_	Survey of World History I or II			3	
CENG 4539	Senior Project	CENG 4518 and approval of dept. chair		3	
	Free Elective (SACS)			3	
CENG 5xxxG	Senior Privilege Graduate Coursework	See following Page	X		X
CENG 5436	Intro to Close-Range Photogrammetry	Approval of instructor		3	
				15	

		Prerequisite	Sem	Hrs	Gr

1. ENGL 2100, ENGL 2111, ENGL 2112, PHIL 2010, or PHIL 2030
2. COMM 1110, ART 1000, ARTH 2531, HONS 1132, HUMN 2321, HUMN 2322, HUMN 2433, HUMN 2434, MUSC 1100, or THEA 1100
3. See back of Curriculum Sheet for a list of Technical Electives. CENG 4890 can be used as a Technical Elective if taken prior to F17
4. BIOL 1230 & 1230L or GEOL 1340 (Required to Graduate with BSCE)

Total Degree Requirements (Hours)	130	Hours	Plus Additional Hours for Embedded Surveying-Geomatics Certificate	18 hours	Equals	148 Total Hours

The required minimum passing grade for all CENG courses is a C;
The required minimum grade for all pre-requisite classes is a C; and
The required minimum grade for all Technical Electives is a C.

Notes: *100 hours of Approved Community Service must be completed prior to Graduation Clearance if you are on the 2015-2016 or newer Catalog*
Students must take the NCEES, Fundamentals of Engineering (FE) Exam (FE-Civil only!) prior to Graduation if you are on the 2016-2017 or newer Catalog

Refer to Georgia Southern catalog for official document.

BSConE: CONSTRUCTION ENGINEERING FOUR-YEAR PLAN INCLUDING EMBEDDED SURVEYING-GEOMATICS CERTIFICATE

Georgia Southern University
Allen E. Paulson College of Engineering and Information Technology
Department of Civil Engineering and Construction Management
Construction Engineering (ConE) Program

Student Name: ______________________

Eagle ID: ______________________

Program Entry Date: ______________________

Completion of all requirements and a minimum of 2.0 GPA are required for graduation.

1st Year

FALL

		Prerequisite	Sem	Hrs	Gr
ENGL 1101	Composition I			3	
HIST 2110 or 2111 or 2112	U.S. A Comprehensive Survey or History of the United States to 1877 or History of the United States Since 1877			3	
MATH 1441	Calculus I			4	
CENG 1133 or ENGR 1133	Civil Eng. Graphics or Engr. Graphics			3	
FYE 1220	First Year Seminar			2	
				15	

SPRING

		Prerequisite	Sem	Hrs	Gr
ENGL 1102	Composition II	ENGL 1101 w/C		3	
PHYS 2211K	Principles of Physics I	MATH 1441 w/C		4	
MATH 2242	Calculus II	MATH 1441 w/C		4	
POLS 1101	American Government			3	
KINS 1525	Concepts of Health & Physical Activity			2	
				16	

SUMMER

		Prerequisite	Sem	Hrs	Gr
CENG 2231 or TCM 2233	Surveying or Construction Surveying	CENG 1133 w/C or ENGR 1133 w/C or TCM 1232 w/C & MATH 1112 or 1113 or 1441 w/C		3	
STAT 1401	Elementary Statistics	MATH 1112 or higher w/C		3	
				6	

2nd Year

		Prerequisite	Sem	Hrs	Gr
ENGR 2231	Engineering Mechanics I	MATH 2242 w/C, & PHYS 2211 w/C		3	
PHYS 2212K	Principles of Physics II	PHYS 2211**K** w/C		4	
TCM 2430	Construction Safety			3	
CENG 1731	Civil Engineering Computations	MATH 1441 w/C Co- or prereq		3	
CENG 5435	Intro to Terrestrial LiDAR	Approval of Instructor		3	
				16	

		Prerequisite	Sem	Hrs	Gr
ENGR 3233	Mechanics of Materials	ENGR 2231 w/C		3	
CHEM 1310	Compreh. Gen'l Chem			4	
TCM 3330	Quantity Estimating	CENG 1133 w/C or ENGR 1133 w/C or TCM 1232 w/C & TCM 1131w/C or permission of instructor		3	
CENG 2131	CE Fluid Mechanics	ENGR 2231 w/C		3	
CORE 2000	Core Capstone Course			1	
CENG 5432	Intro. to GIS in Surveying-Geomatics & Transportation	CENG 2231 w/C or TCM 2233 w/C, or permission of instructor		3	
				17	

		Prerequisite	Sem	Hrs	Gr
CENG 5137	Engineering Hydrology and Hydraulics	CENG 2131 w/C or permission of instructor		3	
ECON 2105	Principles of Macroeconomics			3	
				6	

3rd Year

		Prerequisite	Sem	Hrs	Gr
CENG 3131	Intro to Env. Engineering	CHEM 1310 w/C		3	
CENG 3331	Structural Analysis	ENGR 3233 w/C		3	
CENG 3232	Soil Mechanics	ENGR 3233 w/C		3	
CENG 4135	Highway Design	CENG 2231 w/C or TCM 2233 w/C		3	
TCM 5433	Planning & Scheduling	STAT 1401 w/C and TCM 1231 or permission of instructor		3	
CENG 5433	Drainage & Erosion Control	CENG 5137 w/C or 5137G w/C or permission of Instructor		3	
				18	

		Prerequisite	Sem	Hrs	Gr
CENG 3135/ TCM 3331	Project Cost Analysis/ Construction Finance	ECON 2105 w/C		3	
	Area "D" Science[4]	GEOL 1340 Recommended		4	
CENG 3333	Reinforced Concrete Design	CENG 3331 w/C		3	
CENG 3233	Civil Engr'g Materials	ENGR 3233 w/C		3	
TCM 4710	Construction Internship	Co-req. COOP 4090 (Minimum 320 hours)		1	
CENG 5434	Surveying History & Law	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	
				17	

		Prerequisite	Sem	Hrs	Gr
CENG 5431	Advanced Surveying	CENG 2231 w/C or TCM 2233 w/C or permission of instructor		3	
TCM 3332	Construction Equipment	MATH 1441 w/C		3	
				6	

4th Year		Prerequisite	Sem	Hrs	Gr
CENG 4331	Structural Steel Design	CENG 3331 w/C		3	
TCM 5431	Const. Cost Estimating	TCM 3330 w/C & CENG 3135/TCM 3331 w/C or PoI		3	
CENG 4518	Intro to Senior Project	Sr. Stand & Co- or Prereq CENG 3333 w/C or 4331 w/C		1	
	Area "C" Elective 1[2]			3	
	Area "C" Elective II [3]			3	
CENG 5438 (UD)	Surveying-Geomatics Prof. Practice (TE) (for Construction Elective[1])	CENG 5431 w/C and CENG 5434 w/C or permission of Instructor		3	
				16	

		Prerequisite	Sem	Hrs	Gr
HIST 1111 or 1112	World History I or World History II			3	
	Area "B" Elective[5]	GEOG 1130 Recommended		3	
CENG 4539	Senior Project	CENG 4518		3	
	Free Elective (SACS)				
				3	
CENG 5436	Intro to Close-Range Photogrammetry (for Construction Elective 2[1])	Approval of instructor		3	
				15	

		Prerequisite	Sem	Hrs	Gr

Total Degree Requirements (Hours)	130	Hours	Plus Additional Hours for Embedded Surveying-Geomatics Certificate	18 hours	Equals	**148** Total Hours	

1. See back of Curriculum Sheet for a list of Technical Elective
2. ENGL 2100, ENGL 2111, ENGL 2112, PHIL 2010, or PHIL 2030
3. COMM 1110 Recommended
4. GEOL 1340 Recommended
5. GEOG 1130 is the only Area B Elective that satisfies accreditation requirements. If another Area B course is selected, student will have to also take GEOG 1130 or another Area D elective to satisfy accreditation requirements.

The required minimum passing grade for all CENG courses is a C.
The required minimum passing grade for all TCM courses is a C.
The required minimum passing grade for all pre-requisite courses is a C.
Notes: ***100 hours of Approved Community Service must be completed prior to Graduation Clearance***
Students must take the NCEES, Fundamentals of Engineering (FE) Exam (FE-Civil only!) prior to Graduation.

BSCon: CONSTRUCTION MANAGEMENT (CM) FOUR-YEAR PLAN INCLUDING EMBEDDED SURVEYING-GEOMATICS CERTIFICATE

Georgia Southern University
Allen E. Paulson College of Engineering and Information Technology
Department of Civil Engineering and Construction Management
Construction Management (CM) Program

Student Name: ____________________

Eagle ID: ____________________

Program Entry Date: ____________________

Completion of all requirements and a minimum of 2.0 GPA are required for graduation.

FALL

1st Year

		Prerequisite	Sem	Hrs	Gr
MATH 1112, 1113 or 1441	Trigonometry (3), Pre-Calculus (4) or Calculus I (4)	MATH 1111 w/C		3	
ENGL 1101	Composition I			3	
HIST 2110 or 2111 or 2112	U.S. – A Comp Survey or US History I or II			3	
TCM 1231	Intro to Constr. Mgnt.			3	
TCM 2430	Construction Safety			3	
FYE 1220	First Year Seminar			2	
				17	

SPRING

		Prerequisite	Sem	Hrs	Gr
PHYS 1111K	Introductory Physics I	MATH 1112, 1113, or 1441 w/C		4	
ENGL 1102	Composition II	ENGL 1101 w/C		3	
	Area "C" Elect*			3	
TCM 1131	Building Materials & Systems			3	
TCM 1232	Construction Graphics	TCM 1231 w/C; MATH 1112, 1113, or 1441 w/C		3	
				16	

SUMMER

		Prerequisite	Sem	Hrs	Gr
CENG 2231	Surveying	CENG 1133 w/C or ENGR 1133 w/C or TCM 1232 w/C & MATH 1112 or 1113 or 1441 w/C		3	
STAT 1401	Elementary Statistics	MATH 1112 or higher w/C		3	
				6	

2nd Year

		Prerequisite	Sem	Hrs	Gr
TCM 2235	**Intro to Structures**	PHYS 1111K or PHYS 2211K w/C		3	
KINS 1525	Concepts of Health & Physical Activity			2	
ECON 2106	**Principles of Microeconomics**			3	
HIST 1111 or 1112	World History I or II			3	
CENG 5434	Surveying History & Law	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	
				14	

		Prerequisite	Sem	Hrs	Gr
ACCT 2030	Survey of Accounting			3	
TCM 2234	**Mech. & Elec. Equip. Systems**	TCM 1232 or ENGR 1133 or CENG 1133 & PHYS1111 or PHYS 2211 w/C or PoI		**3**	
POLS 1101	American Government			3	
WRIT 2130	Technical Communications	ENGL 1102 w/C		3	
CORE 2000	Core Capstone Course			1	
CENG 5432	GIS in Surv.-Geomatics/Transport.	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	
				16	

		Prerequisite	Sem	Hrs	Gr
TCM 3332	Const. Equip. Mgmt.	MATH 1112, 1113, or 1441 w/C		3	
	Free Elective (SACs)			3	
				6	

3rd Year

		Prerequisite	Sem	Hrs	Gr
TCM 3231	**Steel Structures**	TCM 2235 w/C		**3**	
TCM 3232	**Concrete Structures**	TCM 2235 w/C		**3**	
**	Area "C" Elective			3	
***	Area "D" Elective			4	
TCM 4710	Construction Internship	Co-req. COOP 4090 (Minimum 320 hours)		1	
CENG 5435	Intro to Terrestrial LiDAR	Approval of Instructor		3	
				17	

		Prerequisite	Sem	Hrs	Gr
TCM 3331	**Construction Finance**	ECON 2106 w/C		**3**	
MGNT 3130	Principles of Mgnt.	Sophomore Status & ECON 2106 w/C		3	
TCM 3330	**Quantity Estimating**	CENG 1133 w/C or ENGR 1133 w/C or TCM 1232 w/C & TCM 1131 or POI		**3**	
LSTD 3230	Bldg. Construction Law			3	
TCM 3333	**Building Codes**	TCM 1231		3	
TCM 5333	BIM for Constr. Mgnt.	TCM 1232 or ENGR 1133 or CENG 1133 w/C		3	
				18	

		Prerequisite	Sem	Hrs	Gr
CENG 5431	Advanced Surveying	CENG 2231 w/C or TCM 2233 w/C or permission of Instructor		3	
TCM 5330	Green Bldg. & Sustainable Construction	Sr. Status or permission of the instructor		3	
				6	

** ENGL 2100, or 2111 or 2112; or PHIL 2010 or 2030
*** GEOL 1340 recommended

4th Year		Prerequisite	Sem	Hrs	Gr
TCM 5433	Project Planning & Scheduling	STAT 1401 w/C & TCM 1231w/C or POI		3	
TCM 4432	Const. Administration	TCM 3331 w/C or CENG 3135 w/C and Jr status		3	
TCM 5431	Const. Cost Estimating	TCM 3330 w/C & TCM 3331/CENG 3135 w/C or Permission of Instructor		3	
*****	Business Elective I	Approval by COBA		3	
TCM 4518	Intro to Senior Project	Senior Status		1	
CENG 5438 (UD)	Surveying-Geomatics Prof. Practice (TE)	CENG 5431 w/C and CENG 5434 w/C or permission of Instructor		3	
				16	

3

		Prerequisite	Sem	Hrs	Gr
TCM 4530	Senior Project	TCM 4518, TCM 5431 and TCM 5433, all w/C		3	
TCM 4434	Soils and Foundations	TCM 2233 w/C or CENG 2231 w/C and TCM 3332 w/C		3	
****	Area "B" Elective			3	
*****	Business Elective II	Approval by COBA		3	
CENG 5436	Intro to Close-Range Photogrammetry	Approval of instructor		3	
				15	

		Prerequisite	Sem	Hrs	Gr

****** GEOG 1130 or FORL 2001 recommended**
******* ACCT, BUSA, FINC, LOGT, LSTD, MGNT, MKTG (3000 Levelor above)**

Total Degree Requirements (Hours)	129	Hours	Plus Additional Hours for Embedded Surveying-Geomatics Certificate	18 hours	Equals	147 Total Hours

Notes:

The required minimum passing grade for all TCM courses is C;
Students must take the American Institute of Constructors, Associate Constructor (Level 1) Exam prior to Graduation; and 100 hours of Approved Community Service must be completed prior to Graduation.
The following courses are reserved for special circumstances, as approved by the student's academic advisor, and may be used in place of other required courses to satisfy the requirements of the major: TCM 3890 Special Problems in Construction (1–3 hrs) and TCM 4890 Selected Problems in Construction (1-3 hrs)

Refer to Georgia Southern catalog for official document

Recommended Curriculum for a Master of Science in Civil Engineering with a ***concentration in <u>Surveying-Geomatics</u>*** (thesis & non-thesis tracks) A minimum of 50% of courses for the Master of Science in Civil Engineering degree must be taken at or above the 6000 level.	
A. Required Core Course	
1. CENG 7031 Res. Methods for CE/CM	3 Credits
B. Specialization Foundation Courses	
2. CENG 5431G Advanced Surveying 3. CENG 5432G Introduction to GIS in Geomatics/Transportation 4. CENG 5434G Surveying History & Law	9 Credits
C. Technical Electives	
5. CENG 5090G Selected Topics in Civil Engineering 6. CENG 5137G Engineering Hydrology and Hydraulics 7. CENG 5433G Drainage & Erosion Control 8. CENG 5435G Intro to Terrestrial LiDAR 9. CENG 5436G Intro to Close Range Photogrammetry 10. CENG 5438G Surveying-Geomatics Professional Practice 11. CENG 7895 Special Problems in Civil Engineering 12. TCM 5330G Green Building and Sustainable Construction 13. TCM 5333G Building Information Modeling 14. TCM 5431G Construction Cost Estimating 15. TCM 5433G Project Planning and Scheduling 16. TMAE 7431 Advanced Quality Control 17. TMAE 7432 Advanced Engineering Economy 18. TMAE 7433 Facilities Planning 19. TMAE 7531 Technical Management and Leadership 20. Or other graduate level courses, as approved by the major professor (Courses highlighted in Yellow plus CENG 2231 or TCM 2233 are required for Georgia Surveying Licensure.)	12 Credits
D. Required Capstone Activity	
20. Thesis: CENG 7999 or Non-Thesis: Master's Project CENG 7891 + 4th Technical Elective at or above the 6000 level	6 Credits
TOTAL	**30 credits**

BSCE + MSCE: CIVIL ENGINEERING + SURVEYING-GEOMATICS EMBEDDED CERTIFICATE: 4+1 ONE PLAN

Georgia Southern University
Allen E. Paulson College of Engineering and Information Technology
Department of Civil Engineering and Construction Management
Civil Engineering (CENG) Program

Student Name: ______________________________

Eagle ID: ______________________________

Program Entry Date: ______________________________

Completion of all requirements and a minimum of 2.0 GPA are required for graduation.

1st Year

FALL

Course	Title	Prerequisite	Sem	Hrs	Gr
ENGL 1101	Composition I			3	
HIST 2110	U.S. – A Comp Survey			3	
MATH 1441	Calculus I			4	
ENGR 1133/ CENG 1133	Eng. Graphics or CE Graphics			3	
FYE 1220	First Year Experience			2	
HLTH 1520	Healthful Living			2	
				17	

SPRING

Course	Title	Prerequisite	Sem	Hrs	Gr
ENGL 1102	Composition II	ENGL 1101 w/C		3	
PHYS 2211	Principles of Physics I	MATH 1441 w/C		4	
MATH 2242	Calculus II	MATH 1441 w/C		4	
POLS 1101	American Government			3	
FYE 1410	Global Citizens	FYE 1220		1	
KINS _____	Physical Activity			1	
				16	

SUMMER

Course	Title	Prerequisite	Sem	Hrs	Gr
CENG 2231	Surveying	MATH 1441 w/C, & ENGR 1133 w/C		3	
STAT 2231	Intro to Statistics I			3	
				6	

2nd Year

FALL

Course	Title	Prerequisite	Sem	Hrs	Gr
ENGR 2231	Engineering Mechanics I	MATH 2242 w/C, & PHYS 2211 w/C		3	
PHYS 2212	Principles of Physics II	PHYS 2211 w/C		4	
MATH 2243	Calculus III	MATH 2242 w/C		4	
CENG 1731	Civil Engineering Computations	MATH 1441 Co- or prereq.		3	
CENG 5435	Intro to Terrestrial LiDAR	Approval of Instructor		3	
				17	

SPRING

Course	Title	Prerequisite	Sem	Hrs	Gr
ENGR 3233	Mechanics of Materials	ENGR 2231 w/C		3	
CHEM 1310	Compreh. Gen'l Chem			4	
MATH 2160	Elem. Linear Algebra.	MATH 1441 w/C		3	
CENG 2131	CE Fluid Mechanics	ENGR 2231 w/C		3	
CENG 5432	GIS in Surv.-Geomatics/Transport.	CENG 2231 w/C or TCM 2233 w/C or Dept. Consent		3	
KINS _____	Physical Activity			1	
				17	

SUMMER

Course	Title	Prerequisite	Sem	Hrs	Gr
CENG 5137	Engineering Hydrology and Hydraulics	CENG 2131 w/C or permission of instructor		3	
ECON 2105	Econ in Global Society			3	
				6	

3rd Year

FALL

Course	Title	Prerequisite	Sem	Hrs	Gr
CENG 3131	Intro to Env. Engineering	CHEM 1310 w/C or CHEM 1146 w/C		3	
CENG 3331	Structural Analysis	ENGR 3233 w/C & MATH 3230 as co- or Prereq.		3	
CENG 3232	Soil Mechanics	ENGR 3233 w/C		3	
CENG 4135	Highway Design	CENG 2231 w/C or TCM 2233 w/C		3	
MATH 3230	Ord. Differential Equations	MATH 2242 w/C		3	
CENG 5433	Drainage & Erosion Control	CENG 5137 w/C or 5137G w/C or Dept. Consent		3	
				18	

SPRING

Course	Title	Prerequisite	Sem	Hrs	Gr
CENG 3132	Intro to Water & Wastewater Treatment	CENG 2131 w/C & CENG 3131 w/C		3	
CENG 3333	Reinforced Concrete Design	CENG 3331 w/C		3	
CENG 3233	Civil Engr'g Materials	ENGR 3233 w/C ENGR 2231 w/C		3	
ENGR 2232	Dynamics of Rigid Bodies	ENGR 2231 w/C		3	
CENG 5434	Surveying History & Law	CENG 2231 w/C or TCM 2233 w/C or Dept. Consent		3	
				15	

SUMMER

Course	Title	Prerequisite	Sem	Hrs	Gr
	Fine Arts Elective [1]	**COMM 1110 Recommended**		3	
CENG 5431G	Advanced Surveying	CENG 2231 w/C or TCM 2233 w/C or Dept. Consent		3	
				6	

4th Year

		Prerequisite	Sem	Hrs	Gr
CENG 5438G (UD)	Surveying-Geomatics Prof. Practice (TE)	CENG 5431 w/C and CENG 5434 w/C		3	
CENG 3135	Construction Cost Control & Finance	ECON 2105 w/C		3	
CENG 4331	Structural Steel Design	CENG 3331 w/C		3	
CENG 4518	Intro to Senior Project	Sr. Standing & Area C Fine Arts Elec.		1	
ENGL 211_	World Literature I or II			3	
	Area D2 Science[2]			4	
				17	

		Prerequisite	Sem	Hrs	Gr
CENG 5436G	Intro to Close-Range Photogrammetry	Approval of instructor		3	
	Social Science Elective[3]	GEOG 1130 Recommended		3	
HIST 1112	World History II			3	
CENG 4539	Senior Project	CENG 4518		3	
	Free Elective (SACS)			3	
CENG 5xxxG	Senior Privilege Graduate Coursework	See following Page			
				15	

		Prerequisite	Sem	Hrs	Gr
CENG 7895	Special Topics			3	
CENG 7895	Special Topics			3	
				6	

5th Year

		Prerequisite	Sem	Hrs	Gr
CENG 7031	Research Methods for CE/CM	Grad. Standing		3	
TMAE 7432	Advanced Engineering Economy			3	
5XXX	Approved Elective			3	
				9	

		Prerequisite	Sem	Hrs	Gr
CENG 7999 or CENG 7891	Thesis or Masters Project			6	
				6	

		Prerequisite	Sem	Hrs	Gr

Undergraduate Notes:

1 COMM 1110, FORL, MUSC 1100, PHIL 2010, RELS 2130, THEA 1100, ART 1000
2 BIOL 1230/1210 or GEOL 1340 (Required to Graduate with BSCE)

3 ANTH 1102, GEOG 1130, PSYC 1101, SOCI 1101, UHON 1131
See back of Curriculum Sheet for a list of Technical Electives. CENG 4890 can be used as a Technical Elective if taken prior to F17

The required minimum passing grade for all CENG courses is a C;
The required minimum grade for all pre-requisite classes is a C; and
The required minimum grade for all Technical Electives is a C.

Total Degree Requirements (Hours)	132 Hours	Plus Additional Embedded Surveying-Geomatics Certificate 18 hours (includes 9 hours credit for both degrees)	Plus 21 Additional Graduate hours	Equals 171 Total Hours

Notes: 100 hours of Approved Community Service must be completed prior to Graduation Clearance if you are on the 2015-2016 or newer Catalog,
Students must take the NCEES, Fundamentals of Engineering (FE) Exam prior to Graduation if you are on the 2016-2017 Catalog (Refer to Georgia Southern catalog for official document)

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