NEW NRC STUDIES
Dave Cowen
NGAC Meeting, September 23, 2010

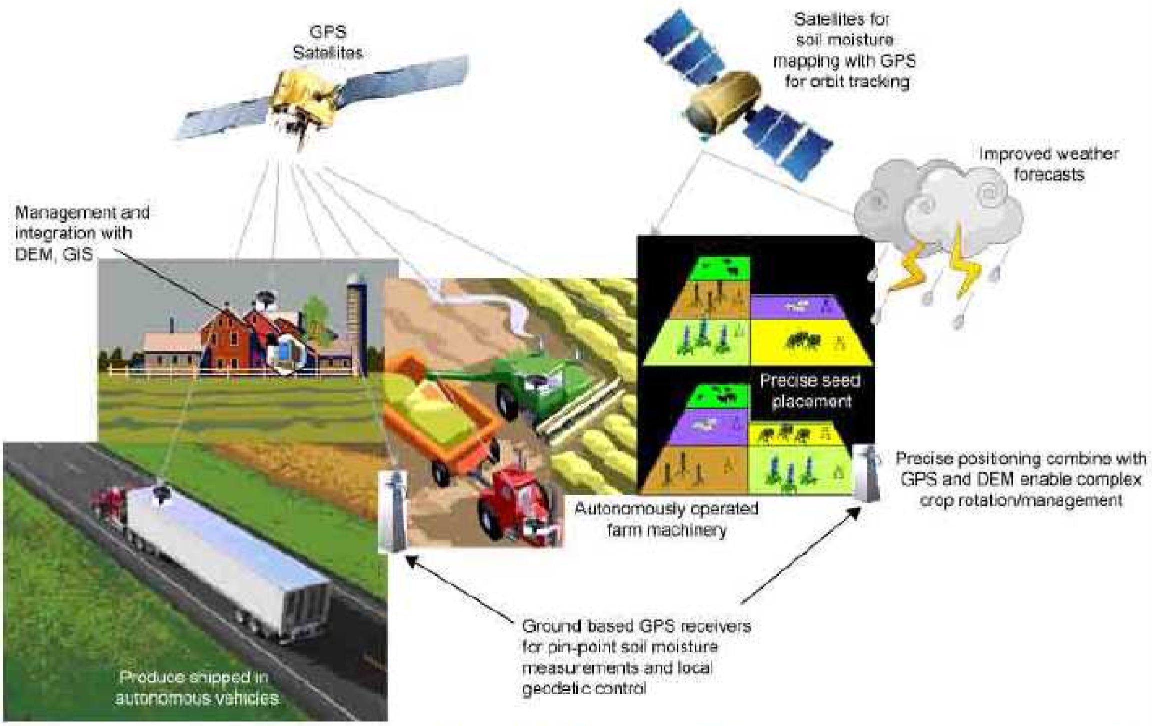
Future U.S. Workforce for Geospatial Intelligence
Origin: Informal request by the NGA Chief Scientist at a meeting with the MSC chair and staff in December 2008
Sponsor: NGA
Statement of Task: An ad hoc committee will examine the need for geospatial intelligence expertise in the United States compared with the production of experts in the relevant disciplines, and discuss possible ways to ensure adequate availability of the needed expertise.
It will:
1. Examine the current availability of U.S. experts in geospatial intelligence disciples and approaches and the anticipated U.S. availability of this expertise for the next 20 years. The disciplines and approaches to be considered include NGA's 5 core areas and promising research areas identified in the May 2010 NRC workshop.
2. Identify any gaps in the current or future availability of this expertise relative to NGA's need.
3. Describe U.S. academic, government laboratory, industry, and professional society training programs for geospatial intelligence disciplines and analytical skills.
4. Suggest ways to build the necessary knowledge and skills to ensure an adequate U.S. supply of geospatial intelligence experts for the next 20 years, including NGA intramural training programs or NGA support for training programs in other venues.
Progress: Funding arrived in August 2010, and nominations are currently being gathered.
Expected Date of Publication: March 2012

National Requirements for Precision Geodetic Infrastructure
Origin: Requested by NASA
Sponsors: NASA, NSF, USGS, NOAA-NGS, DoD-NGA, DoD-USNO.

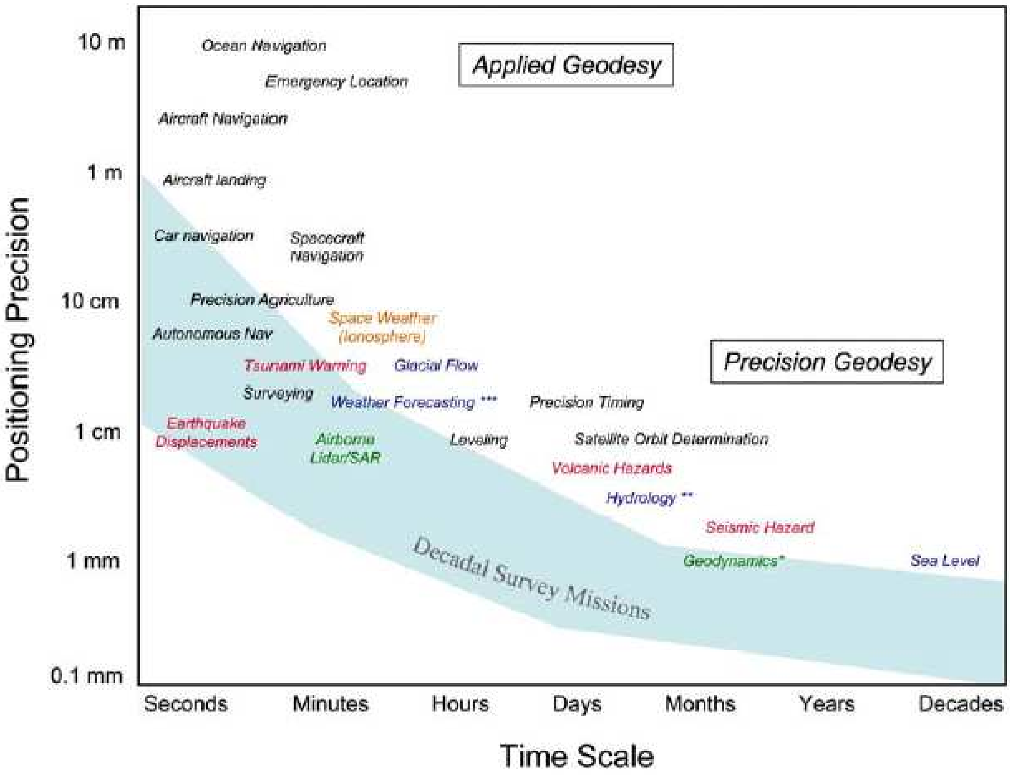
Chair: J. Bernard Minster, Scripps Institution of Oceanography

Statement of Task: Improvements in positioning, navigation, and timing have always driven exploration and understanding of our world. Recognizing the national importance of maintaining and improving the global, high precision geodetic infrastructure that is fundamental to scientific discovery and leadership, and their applications to societal wellbeing and a vast array of commercial activity, an NRC committee will:
a. Describe and assess the range of benefits to the nation that are dependent on high precision geodetic networks;
b. Review high priority scientific objectives that are dependent on geodetic networks;
c. Describe the infrastructure requirements for achieving these objectives and benefits; assess the opportunities for technological innovation that will arise from renewed investment in geodetic infrastructure; and
d. Recommend a national plan for the implementation of a precision geodetic infrastructure.

Box 2.2
Autonomous Farming



Conceptual illustration of the "farm of the future" that could be enabled by the geodetic infrastructure. The global geodetic infrastructure would provide precise positional capability anywhere in the world at all times for precise agriculture applications, including automated farm machinery and precision seed placement. Soil moisture would be monitored by remote sensing and ground-based GNSS/GPS integrated into GIS, providing accurate management of irrigation. Local GNSS/GPS networks would improve local weather forecasts. Accurate terrain, elevation, and land cover information, integrated with



NEW RESEARCH DIRECTIONS FOR THE NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
WORKSHOP REPORT

Description of Research Areas Discussed at the Workshop
Core Areas
Cartographic science—the discipline dealing with the conception, production, dissemination, and study of maps as both tangible and digital objects
Geodesy and geophysics

☐ Geodesy—the study of precisely measuring the size and shape of the Earth, its orientation in space, and its gravitational field in three-dimensional time-varying space

☐ Geophysics—the study of Earth physics, including the fields of meteorology, hydrology, oceanography, seismology, volcanology, magnetism, radioactivity, and geodesy
Geographic Information Systems (GIS) and geospatial analysis

☐ Geographic Information System—any system that captures, stores, analyzes, manages, and visualizes data that are linked to location

☐ Geospatial analysis—the process of applying analytical techniques to geographically-referenced data sets to extract or generate new geographical information or insight
Photogrammetry and geomatics

☐ Photogrammetry—the making of precise measurements from photographs, and the use of the measurements to reconstruct the two- and three-dimensional reference frame of the photograph and objects within it

☐ Geomatics—the discipline of gathering, storing, processing, and delivering geographic or spatially referenced information

Remote sensing and imagery science

☐ Remote sensing—the science of acquiring information using instruments that are remote to the object, such as from aerial or spaceborne platforms

☐ Imagery science—the science of devising and using computational techniques for analyzing, enhancing, compressing, and reconstructing images

Cross-cutting Themes

Beyond fusion—aggregation, integration and conflation of geospatial data across time and space with the goal of removing the effects of data measurement systems and facilitating spatial analysis and synthesis across information sources
Forecasting—an operational research technique used to anticipate outcomes, trends, or expected future behavior of a system using statistics and modeling. It is used as a basis for management planning and decision making and is stated in less certain terms than a prediction
Human terrain—the creation of operational technologies that allow modeling, representation, simulation, and anticipation of behaviors and activities of both individuals and the social networks to which they belong, based on societal, cultural, religious, tribal, historical, and linguistic knowledge; local economy and infrastructure; and knowledge about evolving threats
Participatory sensing—tasks everyday mobile devices, such as cellular phones, to form interactive, scalable sensor networks that enable the public and professionals to gather, analyze, share, and visualize local knowledge and observations. Related terms include volunteered geographic information and community remote sensing.
Visual analytics—the science of analytic reasoning, facilitated by interactive visual interfaces. The techniques are used to synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data.

Visual Analytics. Areas within the field of visual analytics thought worthy of pursuit in the short to medium term included research on the computational modeling of large data sets and their organization for visual processing; models for integrating human intelligence and decision-making into GEOINT systems; building the scientific basis, e.g. theoretical frameworks, for visual analytics; and the integration into visual analytics of concepts from time-space analysis, multi-level data, uncertainty analysis, and humancomputer interaction

Integrating Sensors. Workshop participants indicated that new sensors (e.g., hyperspectral and LiDAR (Light Detection and Ranging)), platforms (e.g., UAV drones, sensor networks and sensor webs, and “small satellites”), and modalities will require new paradigms and significant research in sensor modeling, sensor calibration, and sensor data fusion, as well as new methods to address the complexities of mission planning and adaptation of dynamic tasking. Workshop participants expressed the concern that the vast quantities of data collected will require the development of “smarter” real-time processing and georeferencing methods, perhaps coupled and on-board with sensor platforms. Concomitantly, significant research will be required in automated feature extraction.

☐ **Human Terrain/Behavior.** Workshop participants identified the following as key research areas within human terrain domain: geospatial data collection techniques for observing human behavior; geospatial integration of social, behavioral and cultural data; and the use of participatory data – policy for acquiring, influencing participation, dealing with security and privacy issues, mixing participatory data with traditional data, assessing reliability or credibility, and understanding cultural and social constraints on participatory data.

☐ **Participatory Sensing.** Workshop participants identified the following key elements of a research agenda that will enable effective use of Participatory Sensing in GEOINT: developing methods for planning and optimizing sensing and for incentivization of participants; addressing quality, uncertainty, and trustworthiness of participantcontributed data; and responsibly involving human participants, including addressing privacy and security concerns; integrating unplanned, unstructured participatory sensing data into GEOINT; and, incorporating prior information.

☐ **Improved Models of Space-Time**. The integration of time and space in GIS and geospatial analysis was seen by workshop participants as key to furthering the representation and understanding of complex dynamic physical and socio-behavioral processes. This will require the development of new and improved models that integrate the time structure of events, as well as their aggregates and narratives, with the spatial structure. Crucial in this is a theory of scale dependence in order to handle multiple resolution data bases and the integration of social, cultural and behavioral factors.

☐ **Development of New Paradigms for Conveying Certainty**. Almost all aspects of working group discussions touched on uncertainty as a long term issue that cut across all NGA core areas and that will require more robust treatment. Workshop participants felt that the following areas should be emphasized: the development of tools for establishing data and information quality at all stages of the information chain, from collection to decision making; the creation of methods to establish reliability of participatory sensing data; the development of methods to detect manipulation in participatory data; and means to convey reliability in visual data.

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