4-2012

# Training the Next Generation of Transportation Professionals in Geographic Data Collection, Spatial Analysis and Customer Information

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**National Transportation Workforce Summit – Pathways to the Future**

Topic: Transportation Professional and Continuing Education

Training the Next Generation of Transportation Professionals in Geographic Data Collection, Spatial Analysis and Customer Information

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**Introduction.** Applying advanced technology for transportation research and management has been the focus of Bridgewater State's GeoGraphics Laboratory since 1994. The laboratory has attracted a broad range of students from many academic disciplines and walks of life to engage in leading edge applications of innovative hardware and software to meet the needs of our transportation systems. In some cases, these individuals are recent high school graduates starting their college education. In others, they are "re-entry" students who are re-starting their education after being a homemaker or following a military career. Many are full time employees of business or government entities pursuing part-time graduate degrees or life-long continuing education. The GeoGraphics Lab has provided a laboratory experience for this diverse group over nearly two decades. Geographic technology has changed dramatically over this time. The availability of global positioning systems (GPS) on cell phones is nearly ubiquitous. The increased power and reduced cost of desktop geographic information systems (GIS) has made GIS readily available for every professional of any academic discipline. The availability of timely and useful geographic databases and imagery from government and private agencies has never been better. The ability to create near real-time location information on our transportation system over the Internet has taken customer information to a new level.

This paper will share the authors' experience educating students to take advantage of these twenty first century technologies to improve their value as professionals and improve the capacity of transportation systems. It will outline some of the transportation projects over the past seventeen years that have served as an educational experience for the Bridgewater State University students, describe the institutional approach that has evolved at the Laboratory within the context of higher education, note some of the benefits to faculty and students as a result of this approach, and address some of the inherent challenges posed by non-traditional approaches to educating the transportation workforce of the future.

1. **Addressing Leading Edge Technology Applications for Transportation**. The start of the GeoGraphics Laboratory was marked by two nationally significant events. The laboratory

was established in the new J. Joseph Moakley Center for Technological Applications at Bridgewater State University which, at the time, was the beneficiary of the largest Federal grant to a state college in the U.S. Co-incidentally, the GeoGraphics Laboratory was provided with a transit research grant from the Federal Transit Administration (FTA) to create GIS route systems for the 550 bus systems in the United States. This activity employed up to ten students during two summer sessions (1994 and 1995) digitizing thousands of bus routes across the US in what was jokingly termed by the students as a "GIS sweat shop." This initial GIS database development project included every bus route and every fixed route service in the US as a result of the FTA's implementation of Americans with Disabilities Act (ADA).

The development of the FTA's national GIS routes systems database spawned many other GIS projects for FTA at the GeoGraphics Laboratory. This included a national "level of service" database that documented the start run, end run, frequency of service (headways) by day of week and the calculation of am and pm peak hours of service for every bus route in the U.S. It also included the development of a GIS area database of service areas for paratransit services in the U.S., including contact information for each organization.

In response to a Congressional request for national transit performance measures, an FTA project used GIS analytical tools to calculate the U.S. population living near bus routes by "buffering" GIS bus routes at a ¾ of a mile and ¼ mile distance from the bus route (where the frequency of headways is 20 min or less in the mid-day) and "intersecting" the latest US census block group data. This was a nationally significant applied research project, bringing together several academic disciplines (e.g. transportation geography, mathematics and computer science). The research products provided the FTA policy makers with some very convincing arguments and graphical presentations when discussing the concepts of "basic mobility" and "livable communities" and the role of transit in the United States in geographically specific terms. It provided the students in the lab with a state-of-the-art GIS analytical project that required inter-disciplinary approaches and superior technical skills to complete the project.

Over the years, this research project orientation – based on rapid deployment of GIS databases and related emerging remote sensing and spatial analysis technologies – provided for an organizational and economic model for public-public and public-private partnerships at the GeoGraphics Laboratory built on providing educational opportunities for a diverse student population at the University. These included applied research for a number of U.S. DOT agencies and programs. Research topics included developing mini-Unmanned Aerial Vehicles for transit safety and security, looking at combining satellite and aerial imagery over time and GIS parcel valuation to determine the impact of heavy rail transit on property values, a synthesis study of mobile data terminals in transit, and using web mapping applications to promote intermodal access to the national parks by integrating FTA transit GIS databases and the National Park Service (NPS) area GIS databases

Perhaps the most unexpected and rewarding work at the Laboratory, from the point of view of the students, came from Google. In the first year that Google Labs was promoting the Google Transit Trip Planner at a Community Transportation Association of America (CTAA) conference, the GeoGraphics Laboratory was also presenting real time web mapping of Cape Cod's bus routes and real-time automatic vehicle location of fixed route and paratransit services using a leading edge application of Google Maps. The result was a challenge by Google Transit to the GeoGraphics Lab's students to create further innovations to rapidly deploy Google's general transit feed specification (GTFS) to small transit systems as well as intermodal connections from inter-city carriers. (As a reward, Google came to the laboratory and distributed Google Transit T-shirts to the students.) This partnership between Google Transit and the Laboratory has been a particularly positive one for ensuring continuity at the laboratory for students as they move through their academic journey – the departing students have to train their replacements in the exacting process of creating GTFS databases and maintaining them through transit system seasons and service changes. Having a Google development project at the Laboratory on a student's resume never hurts as they enter the job market (the Google T-shirts took on a life of their own).

Similar stories can be told that include the development of smart phone applications for transit users on the Android, Window 7 Mobile, and Apple iPhone OS from transportation projects at the Lab.

2. **A "Job Shop" Approach to Technology Education at the University level.** While the GeoGraphics Laboratory has a university center/institute status at Bridgewater State University, the incubator laboratory approach that evolved out of the Moakley Center for Technological Applications has significantly different characteristics from the typical academic model.

    a. An institutional public-private partnership has been the core management concept at the laboratory. One co-director is a full tenured professor in the Department of Mathematics and Computer Science. The other co-director is a self employed independent consultant that is a visiting lecturer at the University. The former focuses on the internal processes of the University including recruitment of students and supervision of university research projects that are conducted at the lab. The latter focuses on external marketing, development of sponsored projects and external transportation research opportunities at the Federal, state and local level. At the intersection of these responsibilities, the co-directors share responsibility for strategic planning, project planning and management, and student training and evaluation.

    b. Essential to sustainability of a low-overhead laboratory approach are the following:

- University provided laboratory space
- University supportive programs
    - Work-Study programs
    - Undergraduate research projects
    - Graduate internships/assistantships
    - Facility development and software and hardware upgrades through University Centers overhead support
- University enterprise licensed software for academic research and training (e.g. MSDN license, and ESRI GIS software).
- A 24/7 University data center and free internet backbone.
- Support from the Vice President for University External Affairs for national and international collaboration.
- A laboratory relationship with the private sector, including
    - Microsoft Research project support
    - Microsoft Development Network License
    - Google Labs – beta testing partnership from Google Transit
    - Caliper Corporation – academic teaching and research project support using TransCAD© and Maptitude-for-the Web©
    - Support for applied research by local intercity bus and private livery companies.
- A laboratory relationships with the public sector
    - Federal Transit Administration research projects
    - A Transit Cooperative Research Program (TCRP) research project
    - Research and Innovative Transit Administration research projects
    - A National Highway and Transportation Safety Administration project
    - Cape Cod Regional Transit Authority research application projects
    - MassDOT research application projects.

c. While the project specific orientation of the GeoGraphics Laboratory does not replace the traditional university transportation center (UTC) for the formal development of advanced degree seeking graduate student education, it is a particularly well suited at tackling the application of rapidly emerging technologies. These rapidly changing technologies affecting transportation include wireless communications (e.g. assisted GPS in cell phones, WiMAX, and 4G cellular capabilities), increasingly easy to use GIS database programs with very powerful analytical capabilities, open systems (Android operating system, Open GIS database integration), digital aerial imagery (from satellites, aerial platforms including UAVs), free web mapping applications from Google and Microsoft, and increasingly available geographically referenced public and private databases. All of these developments are of intense interest to students, and most importantly, to their prospective employers.

d. The immutable timing of the academic rhythms provide a framework for developing projects that fit into a semester; winter, spring or summer breaks; a two-year graduate internship or a four-year undergraduate experience. Coincidentally, these timeframes can fit well into the development of projects for Federal, state and local transportation agencies by focusing on the timing of deliverables for applied research into summer projects (labor intensive), short-term projects (maintenance of web based or database projects such as Google Transit Trip Planner projects), or long-term applications (development of leading edge web-based transit information applications for tourist travelers or persons with disabilities). To use the language of manufacturing – this is a "job shop" approach that matches the requirements of external agencies and businesses with the current available labor force (undergraduates or graduate students) looking for a meaningful work experience in emerging technologies.

e. The other immutable fact of a university laboratory is that the student labor force is constantly moving through the institution. Each project has to be tailored to the individual student as they develop particular technical skills in their journey through the university experience, and where applicable, these particular skills have to be passed on to the following generation of student workers at the laboratory. In some cases, an area of research may have to be abandoned or postponed (e.g. application of short range radio communication or universal pricing codes), if there are no students entering the University with this academic interest. A job shop approach to providing university education is essentially the faculty and student focusing on providing a research product or a service for a fee that sustains the educational enterprise. As such, it must be customer-focused and cost-effective, or the customer will stop paying the fee. This university laboratory-as-job shop notion takes a bit of explaining both externally and internally and needs to be understood and supported by the client agency or company and by the university support organizations.

3. **Benefits of Developing a Self-Sustaining Laboratory Approach to Higher Education and Transportation Agencies.** While the development of a job shop approach to a university laboratory is a bit like walking a tight-rope without a net for years on end, there are benefits to both internal and external clients. Since its beginning as a part of the Moakley Center for Technological Applications, the GeoGraphics Lab has completed 50 projects with an economic value to the University of $3.5 million dollars with a total project value of more than $7 million dollars to the community. During this period, the laboratory has continually employed two to ten undergraduate and graduate students at the laboratory every year. Many of these students have gone on to professional employment in the transportation field. Others

have chosen careers in academia or the private sector. Many of these students retain a connection with the laboratory and have been generous with their insights about the laboratory experience as a part of their education. Some of these reflections are as follows.

- Real world problems provide the basis for innovation in technology applications that provide personal challenges and intellectual growth for students, faculty and University support staff.

- Intergovernmental and interdisciplinary collaboration demands clarity of communication and agreement on project goals and end products or services.

- The external project focus of the laboratory provides opportunities for individual leadership by undergraduate and graduate students under faculty and staff supervision.

- Undergraduate and graduate students report that they are more attractive to prospective employers when entering the workforce and better prepared because of their experience working on GeoGraphics Lab projects.

- The application of technology to public and private sectors in a hands-on laboratory setting is particularly effective with recent veterans, who are well schooled in military technology, seeking to enter the civilian workforce after additional training supported by the GI Bill.

- Student presentations and publication of GeoGraphics Laboratory projects hone the student’s writing and presentation skills and provide an opportunity for visibility in the marketplace by future employers or post graduate educators.

4. **Challenges to the “Job Shop” Approach to Workforce Development.** While the benefits of the self-sustaining university laboratory are enough to keep the enterprise going, there are challenges to be overcome as well.

   - Discrete projects with real schedules provide the necessary structure for the academic and private sector cooperation that permit the laboratory to exist. Crafting a scope of work and schedule of deliverables that is mutually agreeable is particularly important to a job shop laboratory approach. A university laboratory should only take on technology projects that are leading edge applications and needs to avoid commercial products or services. However, some external clients are coming to the university shopping for commercial technology at a below market cost. This disparity of perspectives can lead to difficult institutional relationships.

- Limited financial and time resources force the participating institutions and individuals to realistically assess technology applications that fit the timing of higher education and the budgets of public and private participants. The mission of the University is very time sensitive – there is a beginning and ending of every semester– something that is little understood outside of academia. External clients must understand and embrace these temporal rhythms in their expectations for product deliverables.

- Sustaining a self-supporting educational laboratory using a job shop approach is difficult over time as it depends on the personal entrepreneurial efforts of laboratory staff, constantly changing technology, and a constantly changing labor force with different academic and professional interests. Training and ensuring the continuity of essential technical skills is a constant challenge as undergraduate and graduate students move through the academic cycles.

- The dynamics of a laboratory approach to technology deployment has particular human resource dimensions. The student workers move through the laboratory work experience from apprentice to expert in technology application. They must be willing and able to train their successor for their product or service to survive their departure from the University. The laboratory's leadership must deal with the cycles of university grants and sponsored projects: the strategic planning and grant application processes of a university center; project management and reporting on current projects; hiring and managing student personnel; maintaining university research requirements; completing project close-out, post-project reporting and audits.

- A non-traditional approach to higher education and workforce training requires a clear communication between the external (public and private) partners and internal university partners that often have very little contact with the each other's culture. Often, there is little institutional support for the self-supporting laboratory concept, especially when resources are scarce, despite the opportunity for innovation and cost effectiveness.

5. **Conclusion**. Research in science, technology, engineering and mathematics (STEM) education emphasizes the need for hands-on laboratory and small group experiences to improve our global competitiveness. Developing and maintaining a self-sufficient technology applications laboratory at the university level is one approach to addressing these concerns. When Congressman Moakley assisted the University to develop the Center for Technology Applications, his focus was on getting the skills and talents of academia to focus on solving the problems beyond the walls of the academy. Creating incubator laboratories that have to survive by their service to the external community is Congressman Moakley's living legacy to developing the transportation workforce of tomorrow.