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# Embracing Geographic Analysis beyond Geography – Harvard’s Center for Geographic Analysis enters its 5th year

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## ABSTRACT

Without a department of geography, Harvard University established the Center for Geographic Analysis (CGA) in 2006 to support research and teaching of all disciplines across the University with emerging geospatial technologies. In the past four and a half years, CGA built an institutional service infrastructure and unleashed an increasing demand on geographic analysis in many fields. CGA services range from helpdesk, project consultation, training, hardware/software administration, community building, to system development and methodology research. Services often start as an application of existing GIS technology, eventually contributing to the study of geographic information science in many ways. As a new generation of students and researchers growing up with Google Earth and the like, their demand for geospatial services will continue to push CGA into new territories.

*Keywords:* Harvard University, Geographic Analysis, Geospatial Technology, Geography

## HARVARD RETURNED TO GEOGRAPHY

Harvard lost its Geography Department - actually what had become the social geography wing of the Geography and Geology Department - in 1948 (Smith, 1987) and the Computer Graphics and Spatial Analysis lab in 1991 (Chrisman, 2006). By the early 2000s the University recognized that it was missing out on the potential contributions the new geography--the approach to geospatial analysis that combines GIS technology with quantitative analysis--could make to disciplines across the University, from public health to sociology to history. The question the University faced was how most effectively, and quickly, to make it possible for students and faculty to bring geospatial to bear on research and teaching. The Center for Geographic Analysis was established to do just that, with the understanding that faculty appointments would follow as endowment funds for new professorships were raised and as departments came to see the important roles geography could play in their own disciplines (Reed, 2006).

The field of geographic analysis has undergone a series of revolutions over the past half a century. The quantitative revolution brought quantitative analysis into geography in the 1950s, which inspired a new generation of students and scholars (Dutton, 2006). The birth of geographic information systems (GIS) in the 1960s equipped geographic analysis with computers (Niemann & Niemann, 1998). Computer cartography and analysis of remotely sensed images in the 1970s gave the discipline new dimensions. The integration of geographic analysis with numerical

models gained much ground in the 1980s, especially in the field of environmental studies. The information technology (IT) boom in the 1990s gave geographic analysis a swift push into the IT mainstream, complete with relational and object-oriented database management systems (RDBMS and ODBMS), programming platforms, client server architectures, and web based implementations. The completion of the Global Positioning System (GPS) and the ever increasing earth surveillance satellites resulted in an exponential increase of spatial data in native digital format, feeding content to, and at the same time putting pressure on, geographic information systems. Google released Google Maps and Google Earth in the mid 2000s and generated a heightened public interest in geographical issues and expanded awareness of geography in other disciplines. The geotechnology revolution is still ongoing, pushing geographic analysis up to computing clouds and down to mobile devices, and into all walks of life. Its continued growth has expanded the job market for geographers, increased enrollment in geography departments, and brought improvement in geography education at all levels (Murphy, 2007).

In 2003, a faculty committee on spatial analysis was formed at Harvard University. Led by Peter Bol (Figure 1), an historian interested in applying GIS to the study of history, the committee set out to find a solution to address the increasing concerns of faculty and students with improving access to spatial data, support for research employing geospatial analysis, and curriculum development. Two years of investigation and discussion led to the decision by the University to establish the Center for Geographic Analysis (CGA). The inauguration of the Center was held in May 5, 2006 (Gehrman, 2006), “a new dawn for geography at Harvard” (Waters, 2006) (Figure 2).

*Figure 1. Professor Bol addressing the audience at the CGA inaugural workshop on May 5, 2006*

*Figure 2. Harvard Returns to Geography was the theme of the CGA inaugural event.*

## **A CENTER THAT SERVES ALL**

There are two common models of GIS centers in universities. One is department based, such as the three National Centers for Geographic Analysis (NCGA), the GeoPlan Center at the University of Florida, and the Environmental Resources Spatial Analysis Center (ERSAC) at the University of Minnesota. Departments hosting GIS centers include geography, urban planning, and forestry, among others. The other common model of university GIS centers is library based, or library joined with university IT services. Examples are abundant, such as Stanford University, Yale University, MIT, or Rice University.

Prior to 2006, Harvard University had both models. The Graduate School of Design had been offering GIS course modules as part of its curriculum and spatial analysis support by its IT staff. Meanwhile, the Harvard College Library Map Collection also had GIS staff offering spatial data and GIS support to users across the university. However, Harvard faculty and administrators felt that much more needed to be done to meet future demand for geographic analysis.

To the degree that a department based center is focused on serving the hosting department or school it may have few resources left for the rest of the university. A library based center serving the entire university may be limited in its service by the operational conventions of libraries.

CGA was established to overcome these limitations. With a modest start of 3.5 FTE, it has a broad mandate to serve the entire University (Figure 3, 4).

*Figure 3. The CGA is housed in the CGIS Knafel Building. Not to be mistaken as the “Center for GIS” building, CGIS here actually stands for the Center for Government and International Studies, and CGA occupies only a small portion of its concourse level.*

*Figure 4. The central location of CGA on Harvard’s main campus provides convenient access for most of its users.*

At its inception, the CGA was designed to focus on research and education in the field of spatial analysis and geographic information. The Center’s goal has been to work with entities across the university to strengthen university-wide GIS infrastructure and services; provide a common platform for the integration of spatial data from diverse sources and knowledge from multiple disciplines; enable scholarly research that would use, improve or study geospatial analysis techniques; and improve the ability to teach GIS and spatial analysis at all levels across the university.

The early years of the Center have not been without challenges, and a major challenge stems from the fact that Harvard has no geography or geographic information science faculty. For better or worse this has meant that the Center does not have its own research agenda. Instead, its agenda is to enhance research in all disciplines. It does not have a particular interest to serve; its interest is to help all who can benefit from geospatial technology to use it properly.

## **UNSTOPPABLE GROWTH OF DEMAND**

Over the past 4 years, as demand kept increasing, the Center has doubled its annual budget, tripled its staff size, and quadrupled its office space, a significant growth by any standard, but by no means matching up with the rate of growth of demand on its services. Guan and Bol (2009) provides a comprehensive summary of the services offered by the Center, which includes the following:

- Research services
  - Help desk
  - Consultation
  - Project work
  - Contract management
  - Grant proposals
- Teaching and training
  - For-credit courses
  - Non-credit training series
  - Annual thematic workshop/conference
  - Ten-day GIS training institute
- Infrastructure support
  - Site licenses
  - Online data library
  - Hosting of web GIS services

- GPS, plotting and scanning equipments
- Computer labs on both campuses
- Community building
  - Newsletter and website
  - Student award
  - Technical seminars
  - Technology information exchange (blogs)
- Collaboration promotion
  - Cross disciplinary connections
  - Institutional Membership
  - Visiting scholars, research fellows and student interns

Guan et al. (2010) provides a more detailed description of the CGA's role in building an institutional infrastructure for geographic analysis at the University. Figures 5-7 shows the growth of services over time, in both research and teaching. As this service infrastructure gradually takes shape, it benefits not only Harvard scholars, but through them and our collaborators, the world community at large. One such example is the Earthquake Geospatial Research Portal as described in ESRI (2008) and Gudrais (2010).

*Figure 5. Helpdesk incidences accounted for in this chart include visits to the GIS help desks on both the main campus in Cambridge and the medical campus in Boston, as well as email and phone inquiries.*

*Figure 6. CGA staff is invited to give presentations and demos to different groups and at various events on campus, and is involved in many research projects, from a few hours of consultation (free), to a few days of data analysis or mapping (minor), to a few weeks or months of methodology research or system development (major).*

*Figure 7. CGA offers 2-hour hands-on training seminars on Friday afternoons during the school year, gradually adding more modules and increasing the number of sessions.*

## **RESEARCH WITH GIS AND RESEARCH ON GIS**

Started without a geographic information science faculty to drive research on GIS, the CGA focused on using mature GIS technology to enhance research and teaching on all subjects – research with GIS. However, in doing so, we have found that even though mature GIS technology is far from being utilized at its full potential, there are cases when proven technology falls short in solving a particular problem or providing a particular service. Such unmet needs push the envelope of geographic information science itself, and inevitably lead us into the research on GIS.

One such challenge is the need for a system that is publicly accessible, simple to use for non-technical scholars, fast in search and mapping speed, and rich in geographic content. Finding no exiting tool or system that met this requirement, the CGA has made a particular effort to develop a geoportal, first known as AfricaMap (<http://africamap.harvard.edu>), which has since evolved into the WorldMap system.

WorldMap is a web based and map centric data exploration system that is built on the open source geospatial technology. Its first implementation, for the continent of Africa, with a beta release in November 2008, has proven to be an effective solution for integrating and making accessible dispersed humanities collections, combined with a wealth of mapping materials, to allow for cross-disciplinary inquiries from a spatial perspective. AfricaMap has since been cloned to create portals focused on other parts of the world, including Boston, Vermont, Paris and East Asia, collectively called WorldMap.

WorldMap is designed to handle an unlimited amount of data content, not only by the scalability of its system servers, but more importantly through its service oriented architecture that allows the system to connect to remote systems, to search for, request for and display materials hosted on them, following the Open Geospatial Consortium (OGC) standards. In return, materials hosted on the WorldMap servers are available for other systems' live consumption as well. The system handles both mapping data and data in any format as long as it has a geographic location associated with it. Examples include YouTube videos, Picasa photos, museum collections, library archives, wired news, selected blogs, etc. The several million place names in its gazetteer allow for rapid search of even remote locations, and quickly zoom to the selected vicinity. The user may select several data layers to overlay together, and has full control of transparency for each layer, allowing for visual investigation of spatial patterns and relationships. The power of WorldMap is on its ability to integrate an ever expanding data collection stored locally and remotely, its flexibility on focusing on any particular theme (defined by the filtered data layers) on any geographic extent (from the entire world to a city neighborhood), and its interactive tools allowing users to discover, combine, and visualize materials from different sources, in different formats, with different languages, but all organized through a map (Lewis & Guan, 2010).

The usefulness of the WorldMap system has generated much enthusiasm among a broad user community inside and outside of Harvard, as well as strong demands for its expansion and enhancement. Based on the beta release of its proof-of-concept implementation, CGA is actively planning for a 2nd phase of design improvements to facilitate greater scholarly collaboration.

Another project, the Digital Atlas of Roman and Medieval Civilization (DARMC <http://darmc.harvard.edu>), applied off-the-shelf web mapping technology (ArcGIS Server), but encountered a number of unconventional issues in its geodatabase design, such as the life span of historical objects and events, uncertainty and nonstandard time definitions, and the verification and consolidation of multi-source scholarly inputs. Similarly, the China Historical GIS project (<http://www.fas.harvard.edu/~chgis/>), another example of GIS supporting humanities and social sciences, not only applied mature GIS database and mapping technologies to historical data, but also touched on some thorny spatial-temporal modeling issues, such as representing hierarchical relationships of historical administrative units whose polygonal boundaries were never defined or not known, or retrofitting historical population distribution to a finer scale based on modeled natural, economical and social environment over the historical landscape (Berman, 2005, 2007).

These projects often started as an application of existing GIS technology, eventually contributing to the study of geographic information science in many ways. Unlike stable business operations in the industrial or public sectors, academic research in any discipline constantly explores new approaches, new analytical means, and new perspectives on very diverse objects and processes. They present a strong demand and ample testing cases for the study of new scientific methodology. The CGA is uniquely positioned at the crossing point of research with

GIS and research on GIS. It is firmly based on the former, with much potential to grow in the latter.

## WHAT COMES NEXT?

By tradition Harvard University is a distributed system, with each organization operating with a high degree of autonomy, described as “every tub has its own bottom.” Five years into its operation, the CGA has yet to reach out to all potential users. Outreach and coordination continues to be major tasks for the CGA, competing for limited resources with technical projects. Moreover, for users who are familiar and satisfied with CGA services, the CGA has become their “one-stop shop” for technology support. It is often hard for a scholar to clearly define the different technical domains that speak to his/her project’s needs. Oftentimes one project needs data acquisition, database design, web development, geographic analysis, and statistical modeling. The researcher may not be familiar with all the specialty support teams scattered across the University for each of these components. They may rely on CGA, or whichever team that they are most familiar with, to help them define their project scope, identify technology needs, and establish initial contact with the other specialty teams.

The rapidly evolving geospatial technology blurs boundaries between CGA’s core technology domain - GIS, and related IT domains such as database design, web design, cloud computing, etc. CGA is riding important current trends such the open source, open standards, crowd sourcing, and service oriented architecture, pushing the technology envelopes while applying the technology. Some of the projects under planning include the development of a “Map OCR”, or map-based optical character recognition system which automatically recognizes and extracts text labels and spatial features from scanned maps while maintaining their geographic registration and feature-label relationship; a global temporal gazetteer; a system for mapping non-spatial contents to support location based inquiries and reasoning, etc. Looking forward, a new generation of students and researchers has grown up with Google Earth, iPhones loaded with maps and GPS, georeferenced tweets, etc. Their demand for geospatial services will continue to push CGA into new territories.

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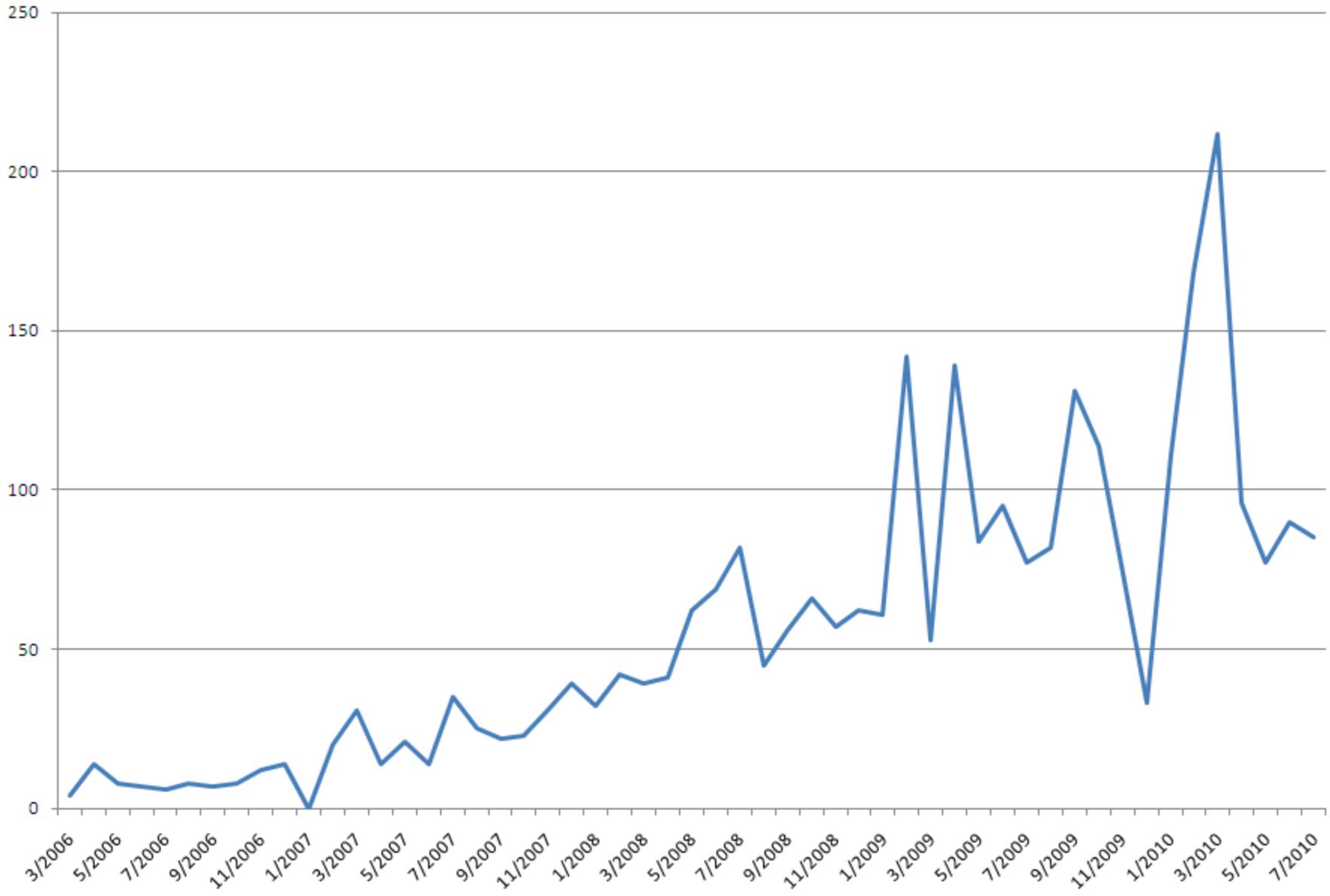
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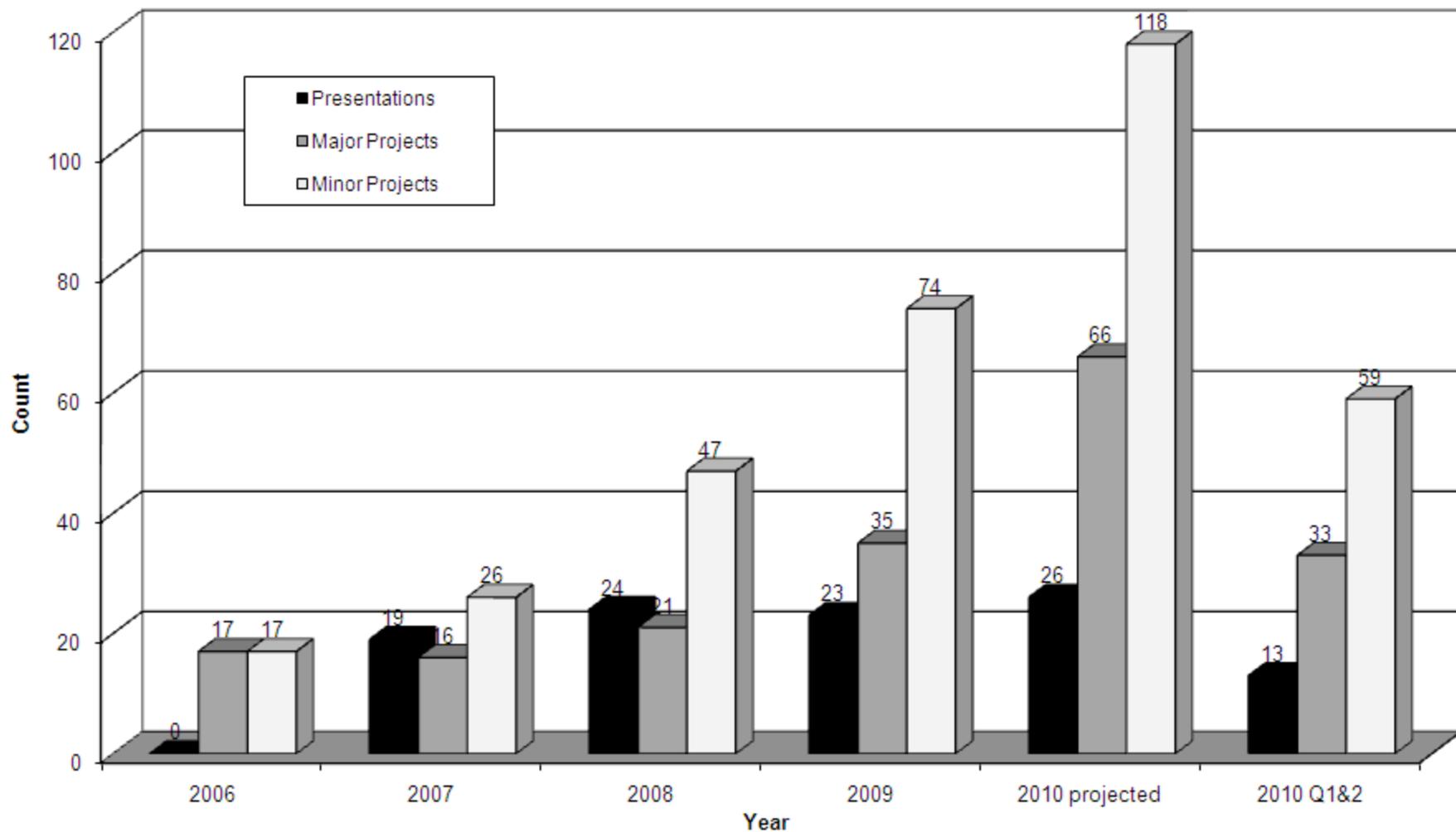
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# CGA Help Desk Ticket Count



### CGA Service Projects and Presentations



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