UOB Experience in GIS Education: A Case Study

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Abstract:

The number of Geographic Information Systems (GIS) users In the Kingdom of Bahrain has been rising considerably. GIS entered the curricula of the University of Bahrain (UOB) formally in the mid-1990s, when the BA Applied Geography (AG) program was launched. Few years later, based on the emerging concepts of Geographic Information Science (GISc), a new academic program was introduced in 2004: BA in Applied Geography and Geographic Information System (AGGIS). AGGIS is a single major program and largely multi-disciplinary program embracing a number of broad academic disciplines. It depends upon the use of the latest technology and industry standard software. The program's mission was formulated to give insights into the science (GISc) without compromising the technology (GIS). It is believed that it stands up to the needs of the local demand for specialists in the field.

Keywords: Applied Geography, curriculum, education, relevance, Spatial Information Industry (SIS), job market.

1. INTRODUCTION

The convergence of the discipline of geography and that of Information Technology (IT) has resulted in the birth of a new Spatial Information Industry (SII). The industry characterizes businesses trading in location-based products and services. Consisting of a multiplicity of spatial data activities (collection, storage, manipulation, analysis and display), SII comprises three broad elements: technology providers (hardware, software and database systems), data providers (capturing, manipulating and supplying raw data) and service providers (undertaking the value-added supply of spatial information products to customers; usually for business purposes). With such components, SII stands as an upstream industry trickling down its effects to a multitude of downstream industries, thus contributing to the development of the society's economy, not only in monetary terms but also as a key player in the process of sustained development. Indeed, it brings sophisticated skills and technology to the major challenges facing the human society.

It is within this perspective that SII has grown rapidly over the past ten years or so. Demand for its products has been growing steadily, being used in a wide variety of

applications. It has grown into a multibillion industry and has become a major world growth area. The annual worldwide expenditure in SII (software, hardware, training and data) was estimated in 2002 to be of the order of $34 billion (cf. Hunter and Ogleby, Web ref.). Indeed it has become a profitable enterprise. In a recent presentation, Lawrence (2007) mentioned that geographic information from the Ordnance Survey (UK) alone is said to underpin in excess of $200 billion of GDP per annum (some 8% of Britain's GDP). Meanwhile she reported an annual turnover of this information in 2006/07 in the tune of $232 million.

However, as an expanding industry growing at a rate of nearly 30% over the period 1998-2002 (ESRI, Web Ref.), it has created strong demand for graduates trained in GIS and spatial thinking. A notable shortage of specialized personnel at the different levels of skills since GIS emergence in the late 1980s on both sides of the world (North and South) has been noted by Bishop et al (2000). Inevitably, governments all over the world have geared a sizeable amount of investment towards the skilling of its workforce and the development of strategies and polices that ensure viability and growth of SII.

Accordingly, the academic arena has responded swiftly to the expanding SII in an attempt to bridge the gap between supply of specialists and demand for it. There has been a tremendous growth of GIS programs in colleges and universities. This growth is reflected in the fact that in 2002 there were more than 6,500 colleges and universities worldwide using ESRI's GIS software alone in teaching and research activities in more than 70 disciplines and academic departments (ESRI, 2002, p.6); let alone the rest of software packages produced by other vendors.

Since its introduction in the Kingdom of Bahrain in the mid-1990s, GIS has been acquiring a unanimous importance as a mainstream technology within the government, municipalities and businesses. Yet, the notable shortage of specialized personnel at the different levels of skills remained, however, an obstacle to the widespread and efficient use of the technology. In this context, the question is not the clever smart fingers operating the technology as much as it is those mentalities who understand the theory behind the technology and its application. Frame the issue into a wider perspective, it is a question of the skills needed to understand and apply spatial reasoning. Within this perspective, UOB's Applied Geography and Geographic Information Systems (AGGIS) was introduced in 2004 as a single major program emphasizing theoretical, technical and vocational oriented course modules.

The present paper attempts at examining UOB's response to the increasing use of GIS and the growing demand for its specialists in the Kingdom, focusing primarily on AGGIS as the first and sole comprehensive GISc program in the UOB. The question of difficulties and challenges constraining the design process of GIS curricula in general is addressed briefly. Meanwhile, AGGIS is assessed in light of its philosophy

and relevance to the local needs, as reflected by the kingdom's actual demand for specialists of various skills in the field.

2. GIS IN THE KINGDOM OF BAHRAIN

There has been a growing awareness of the great importance of GIS in the Kingdom of Bahrain. Over the past few years GIS, as a technology, has become a major growth area in the country. At present there are few government organizations that do not utilize GIS in some way in managing their data and assets, and for aiding many of their strategic decisions. Indeed, GIS is now accepted in the Kingdom of Bahrain as a mainstream technology within local government and utilities, particularly for managing infrastructure. Meanwhile it plays a predominant role as a key tool for the local environmental and natural resource management agencies.

Realizing the importance of GIS in the Kingdom, the government of Bahrain took the matter into her hand in 2004. A Cabinet Decree (No. 3/2004) was enacted to represent a clear recognition of the importance of GIS as an indispensible tool in management and decision support. The decree established a national committee for Geographic Information Systems (NCGIS). Headed by the Minister for Cabinet Affairs, the Committee members comprised key posts in Ministries and organizations involved in the production and use of spatial data (Table 1). Unfortunately, the committee did not include any members of the only educational and research institution that has the capabilities and resources to present GIS education, i.e. UOB.

Table 1: NCGIS Members

Organization	Number of Members
Central Informatics Organization (CIO)	1
Ministry of Electricity and Water	2
Ministry of Housing and Works	2
Ministry of Municipalities and Agriculture	1
Survey and Land Registration Bureau	3
Bahrain Petroleum Company (Bapco)	1
Bahrain Telecommunications Company (Batelco)	1
Bahrain Centre for Studies and Research	2
Total	**13**

Source: http://www.cio.gov.bh/default.asp?action=category&ID=184

The committee's task, as stated by the decree, is to supervise the construction of a national geographic database and to work towards the establishment of an Integrated National Geographic Information System. The Decree detailed this task into a number of objectives, the most important of which are:

1. Proposing the strategy, criteria and control of geographic information use.
2. Reviewing administrative procedures and the coordination of joint projects between Ministries and other government bodies; to avoid work duplication.
3. Using GIS capabilities in increasing the efficiency and efficacy of ministries' as well as public and private organizations' performance in the Kingdom.

In fact, the kingdom has been witnessing a great deal of GIS activities since long before the set up of NCGIS. These activities are evident in many aspects of the country's organizational and business arena. They can be classified into three complementary levels: government, professional and research and business levels. On the government level, a notable number of agencies have introduced the technology into their strategic business plans. The most notable examples in this respect are the Central Planning Unit (CPU) of the Ministry of Housing and Works, the Survey and Land Registration Bureau, Central Informatics Organization (CIO) and Ministry of Municipalities and Agriculture.

The results of a recent survey carried out by the Department of Social Sciences at UOB (DSS, 2005: 14) indicate that GIS technology is used at present in various tasks in a wide variety of governmental agencies as well as local government and municipalities. In addition to those mentioned above, these organizations include:

- Ministry of Electricity and Water.
- Bahrain Petroleum Company (Bapco).
- Bahrain Telecommunications Company (Batelco).
- Ministry of Interior (which has recently developed its own Geographic Security System (GSS).
- Ministry of Health.
- Wild life and Environment Protection Committee.

As for the second level, there has been a sporadic awareness of GIS among some professional syndicates and societies. One good example in this context is the Bahrain Society of Engineers which organized a series of four conferences between 1998 and 2007; the latest of them was "Spatial Technology: Stretch beyond GIS", held in December 2007. Moreover, the kingdom has recently hosted the 8th Middle East Geosciences Conference and Exhibition (GEO 2008) in March this year; a conference that is thematically concentrating on the use of GIS in the petroleum, petrochemical and natural gas industries.

On the third level, Bahrain Centre for Studies and Research has also been paying a strong and special attention to GIS technology since late 1990s. It carried out a number of various studies on Bahraini environment, agriculture and fisheries using GIS. The activity of the center was culminated by the establishment of "Geomatic"; a

company that runs on business basis producing SII products and services. The firm is only recognized agency working as a profit organization in the field in the kingdom.

Activities on the three aforementioned levels suggest a sizable involvement in the use of GIS and a growing awareness of its overwhelming importance.

However, the question remains: to what extent could the local labor supply meet the increasing demand for skilled personnel at all levels of skills required to stand the aspiration of the expanding GIS job market. All the above mentioned Ministries and agencies, in addition to a number of private companies, rely heavily on non Bahrainis to satisfy their needs. The DSS report suggests that some 80% of the interviewed organizations affirmed their needs to train their manpower in the field of GIS (DSS, 2005: 25). In addition, there it ascertains that there is still much scope for GIS use in the Kingdom, as a number of the interviewees expressed their lack of knowledge of GIS technology (which they have not known about it yet) and its great contribution to increasing the efficiency and efficacy of their work.

3. GIS EDUCATION: CHALLENGES AND CONSIDERATIONS

Designing a proper GIS educational program or, more precisely, a curriculum is not an easy task. It embraces a number of steps and faces a variety of constraints, difficulties and challenges, which have been the subject of a good number of assessments carried out by some of the prominent authorities in the field (e.g. Unwin, 1998; Parihar, Web ref.; Rhind and Raper, Web ref.). Indeed, there is no single correct answer for the question of the proper curriculum of GIS. The following is a highlight of some of the most important technical and academic issues in this respect.

First: The diversity of the technology users

GIS users are very diverse, cutting across many fields of interests and a variety of academic subjects in which the spatial dimension has specific bearing. In some cases GIS use stands as a specialist activity, whereas in others the main concern is focused upon using some querying and mapping capabilities incorporated in the specialist modules of the software; in such cases, users need not necessarily have the technical know-how of GIS. In this latter case GIS university education can become a part of a wide range of subjects, from Civil Engineering, through Natural Sciences, to the wide variety of Social Sciences.

Second: The difference in perspectives and emphasis

Essentially GIS accommodates three main areas of interest: data, operations and applications. Each of these areas constitutes an educational perspective on its own merit. The data perspective is, by default, the primary concern of affiliates of geography, geology and architecture, as they usually embark on data preparation and database assembly. The discipline of geography, in particular, has the additional

concern of analysis and spatial reasoning within the wider context of its holistic approach. The operation perspective, on the other hand, is a property of the discipline of computer sciences, where the main focus is on refining and expanding processing and display capabilities of the technology, in addition to the primary concern of constructing the logical and internal models of reality. The application perspective is a common domain for all physical and social sciences affiliates who, by nature, do not give much attention to details of spatial data and operations; in many cases such details are viewed as impediments to the users' problem solving tasks.

Recent experience in GIS use, however, has shown that there has a marked shift towards emphasizing the application perspective of the subject; thanks to the great advances of the software which made things much easier. It is worth mentioning, however, that a curriculum would definitely reflect the scientific background not only of its designers, of its implementers.

Third: Education or training?

GIS is usually introduced as a technology or a technology driven industry, yet it rests on top of many years of a sizeable work in *spatial information science* (SIS). The 'education - training' debate influences not only the overall aims and objectives of the educational program, but also affects its contents and delivery mode. Choosing between education in the concepts of SIS and training in the use of a specific system depends, in part, on the levels of skill needed for a variety of possible future involvements with GIS, from operative to system designer (cf. Toppen, 1992). Unwin (1998) was decisive when he ascertained that no single curriculum could hope to meet all these requirements.

Fourth: Breadth or depth?

A GIS university curriculum must aim at equipping students with a breadth of vision to understand not only the scientific and societal problems to which GIS might be applied, but also the complex managerial, legal and ethical questions that might arise from the technology use. It must, meanwhile, provide students with the depth of understanding to be able to play what Douglas (1988) once referred to as the 'hardball' version of GIS; i.e. to apply concepts from database management, computer programming etc., to the apparent chaos of the real world and to its complex problems and diverse 'messy' data. It is indeed the balance between breadth and depth that is the most important curriculum design challenge of all.

UOB EXPERINCE WITH GIS EDUCATION

4.1 Retrospect: the beginnings

UOB experience with GIS education goes back to the mid-1990s. GIS was delivered in two of the university's colleges as a sub-set of other disciplines in two different

modes. In the College of Science it has always been, and still is, an elective course within the curriculum of a minor degree in Computer Science. On the other hand, GIS is employed as a teaching aid in two BSc degrees in the Department of Civil Engineering: Civil Engineering, and Architecture. In Civil Engineering, it is used for application in a senior project course. In Architecture, however, it is employed in some of the program's elective courses (in particular: Urban Planning, Urban Design and Environmental Design). In either case there is no stand alone course of GIS on its own right. It is believed, however, that a mandatory GIS course is planned to be introduced into the department curricula, possibly next year.

The first full academic BA program to contain an explicit GIS syllabus was the BA in Applied Geography (AG) introduced in the Department of Social Sciences of the College of Arts in 1997 as a major specialization[1]. At the time of its launching, it is believed, it stood as a pioneer in the field, as it was the first of its kind at university level in the Middle East, because it hosted two direct courses of Geographic Information Systems (GIS), as well as a host of supporting courses in cartography, plane surveying, remote sensing, aerial photography, statistical analysis and spatial analysis, which are central in teaching modern geography degrees in general. In principle, the degree originally had its foundations in geographic and cartographic sciences. Approaching GIS in AG has, to a large extent, followed a conventional methodology of lecturing on theory and practicing using the well known university developed software package of IDRISI.

4.2 Applied Geography and Geographic Information Systems (AGGIS) program

The Applied Geography and Geographic Information Systems (AGGIS) BA degree program was introduced in 2004 to represent a clear departure from the simple concepts and applications to the wider domain of geographic information science (GISc) and technology with all its allied applications. Being a single major, it stemmed as a distinct program, radically different from its predecessor (AG). It integrates materials from several other disciplines into one distinct science of spatial information that is worthy of study in its own merit. In addition to theory in geography and spatial information science, AGGIS equally emphasizes technical and vocational oriented course modules, which makes it a fundamentally professional geographic and GIS degree structured to fit the specification of the local demand for professionals in the field.

Arguments and debate on where to house AGGIS within UOB academic departments were firmly settled. Decision makers at the highest university level were fully aware of the necessity of accommodating the program within the geography house. The

[1] The program degree consists of 132 credit hours, of which only 69 credit hours for the specialty courses (geography), while the rest were devoted to university and college requirements (33 credits) as well as the minor specialization (30 credit hours) in some supporting discipline.

adjective **'geographic'** in the term “Geographic Information Systems” has helped a great deal in this respect, as educating GIS has, traditionally rested in the academic Departments of Geography. Indeed, many of the antecedents of GIS (computer cartography, remote sensing and spatial analysis) were firmly located in the departments of geography all over the world and have remained as such. The Catholic relationship between GIS and the discipline of geography cannot be simply overviewed. In this respect, Demers (1999) was decisive in inviting all to become geographers, if not by vocation then by avocation, as he affirmed that GIS is about thinking geographically. There is, indeed, an institutional geography to the need for GIS skills and knowledge, and GIS education has to recognize that fact.

The question of the technical underpinnings of GIS (e.g. geometry, database management) has been fairly addressed, however, through the cooperation with the college of IT, which took the responsibility of designing and teaching three of the core IT courses of the program.

4.2.1 Design Methodology and Considerations

Originally, the idea of AGGIS stemmed from a sincere desire to upgrade the existing AG program to match the universal shift in university education from GIS to GISc, coping with two important developments. On the one hand, there were a great deal of dramatic and rapid changes both in geographic theory and practice, and GIS education taking place elsewhere in the advanced universities. On the other hand, there was a notable expansion in the local Bahraini market for SII products and services and an acute short supply of highly specialized and skilled personnel.

Accordingly, an extensive detailed examination of a great deal of curricula introduced in reputable universities was undertaken, while examining, very closely, both versions of NCGIA core curriculum (1990 and 2000) which were of a great assistance in this respect. Meanwhile, some extensive preliminary studies of the SII local market were carried out to identify its actual needs of specialists in order to gear the program structure towards them. The studies included a series of workshops and seminars involving specialists, GIS users and decision makers in both the public and private sectors, and a field survey involving all the concerned authorities and organizations to grasp the reality of GIS use and its future prospects in the kingdom and tailor the technical and application modules of the program accordingly.

With these studies in hand, two questions were raised, one was the overall program structure as well as the detailed description of each single course and how it ought to be taught. The second was how to increase the productivity of the program and raise its efficiency.

As for the first question, it concerns the fact that GIS is a multifaceted field with different conceptions for different user backgrounds; different prejudices to GIS are

inevitable for the diversity of its users. Different businesses need different contextual knowledge and application-specific experience. Yet, in the job market employers do not need just clever fingers and packaged solutions, but they also apt for multidisciplinary skills and institutional awareness. Accordingly there is no single answer to this type of question that suits all situations. To compromise these needs, AGGIS was structured considering the reality that GIS is at present GI Science, GI Systems, GI Studies and GI (Geographic Information), increasingly involved in G-Business. While emphasizing core ideas and concepts, a great deal of attention was, at the same time, given to as many different real world situations as possible in the description of each of the program courses.

Another point of interest here is the fact that, as a discipline, GIS can be taught at two distinct levels: technology and the concepts behind technology. In a university GIS educational program the two levels cannot be separated. Knowledge of geographic principles driving spatial patterns and dynamics strengthens the accuracy of the analysis to solve real world problems. Indeed it is the ability to think and analyze spatially that constitutes the core of GIS and, meanwhile, makes the tool a very powerful one. The nature of the discipline of geography with its distinct relationships with its border disciplines has made achieving this end in AGGIS possible. A balanced dose of basic and applied geographic course module proved to be very helpful in this context.

As for the question of raising the program's productivity, it concerns the difference between teaching GIS and teaching with GIS. Thompson (1992) noted that practitioners of the first party far exceed their counterparts in the latter one. The course description of the basic and applied geography course module of the program curriculum ascertained delivering these courses using GIS, even though the course titles may not prefixed GIS explicitly. In this way the use of GIS is overwhelmingly emphasized and experience with it is enriched.

Finally, within this multiplicity of considerations AGGIS was designed as carefully as possible through a general approach adapted to local and specific circumstances, resources and students abilities and needs.

4.2.2 Program structure

The program comprises 126 credit hours split up between university, college and departmental requirements. University and college requirements together attain 27 credit hours, and the rest (99 credit hours) is devoted solely to the specialty courses. AGGIS is a single major, multidisciplinary program with a strong emphasis on geographic concepts and theory. Its contents comprise several core geographic and geographic information-related subjects of geography, cartography, remote sensing, digital image analysis, database management environmental sciences regional and physical planning and IT. As it was mentioned earlier on, the IT course module was

designed and is taught by the College of Information Technology in UOB. AGGIS balances between academic systematic knowledge, modern technology skills and field work, and specialization in specific field, each covered by a course module (Table 2).

During his study in the program, the student is exposed to a carefully-designed computer-based teaching process and projects.

Table 2: Course Module Components of AGGIS

Course Module	Units (Courses)	Hours (Credits)	% Credits
Basic & Applied Geographical	10	33	33.3
GIS Supporting Courses	4	12	12.1
GIS & Spatial Analysis	12	36	36.4
Application Specific Areas*	6	18	18.2
Job Market Training**	1	--	--
Total	**31**	**99**	**100.0**

* Application area is either Regional and Physical Planning, or Environment and Natural Resources.
** Non credit compulsory course; a precondition for graduation.

4.2.3 Practical Training and fieldwork:

Following the Chinese proverb: *'Tell me, I forget; show me, I remember; involve me, I understand',* practical application, training and fieldwork are central to the AGGIS program. A successful establishment of a profound understanding of the geographical theory underlying GIS can only be achieved through practical application, training and fieldwork. Practical training and fieldwork are an integral part of almost all courses with varying degrees, but they generally account for 40-50% of course class hours, according to the nature of each course. Training and fieldwork is designed along four complementary lines:

1. ***Internal Lab Applications:*** Applying theory on real world geographic problems within the GIS laboratories at the Department of Social Sciences (3 computer labs, each equipped with 20 state-of-the-art PCs and the latest software: SPSS, ArcGIS 9.1and IDRISI Kilimanjaro). Course specific data is mostly scanned and digitized.
2. ***Course Specific Fieldwork:*** Using state-of-the-art equipments in field data collection (GPS, GPR, Total Station, Theodollite and Level), students are trained to collect spatial data in the field, and to refine it in the labs before using it in further assignments.
3. ***Professional:*** Students are assigned various tasks for designing and implementing GIS applied projects. Using the refined data, they are requested

to build up their own databases following careful steps under staff supervision. Bahrain's data attains special attention.

4. ***Direct job market training:*** Within the framework of a mandatory non-credit course (Practical Training) students are attached to one of the Ministries, organizations and agencies involved in GIS use for a two-month training program. The course is graduation requirement for it exposes students to real-life issues and problems and enhances their experience in dealing with them..

4.2.4 Outputs: relevance to the job market

Educational and training programs are usually designed to fulfill specific purposes and meet definite needs to the society they are supposed to serve. The available resources are used efficiently to ensure qualifying graduates to the highest expected standards. AGGIS graduates are systematically equipped with the necessary professional skills of the field within a highly framed geographical perspective. Examples of these skills are:

- Sound understanding of scientific and information technology principles and methods.
- Deep knowledge of geography and geographic information science and technology that enables them to competently enter the Spatial Information Industry (SII).
- Deep technical knowledge and skills in GIS application development.
- The capacity to apply the analytical skills in real situation problem solving and system design.
- The capacity to communicate effectively in the context of defining and solving problems.
- Understanding of the roles and responsibilities of the professional groups engaged in the Spatial Information Industry (SII).
- Understanding of the extent to which team work underscores successful geographic and information technology solutions in Spatial Information Industry (SII).

The job market for the AGGIS graduates covers a wide spectrum of fields in various Ministries, organizations, institutions and companies in both sectors: public and private (cf. Section 2). Actually, it builds its success on the fact that the number of organizations dealing with data in general and geographic data in particular, is growing; going hand in hand with the present tendency of the Kingdom of Bahrain towards the adoption and implementation of geo-databases and GIS nationwide.

The Department of Social Sciences has designed a questionnaire to measure the relevance of AGGIS contents of knowledge and skills to the local job market. The questionnaire was applied to ministries, organizations and agencies involved in GIS use, or those planning to introduce it to work flow. The received response data were processed, manipulated and analyzed independently by the UOB Centre of

Measurement, Evaluation and Academic Development. The results revealel a number of significant points (DSS, 2005: IV-V):

1. Opinions of the ministries, organizations and agencies participating in the survey awarded AGGIS a great importance, and expressed their need for its constituent parts and techniques.
2. Some organizations have recently introduced GIS into their work, but they do not have enough numbers of qualified and specialized cadres yet.
3. A number of organizations are still preparing the necessary viability studies of introducing GIS into their work flow; a situation that ascertains a future need for qualified cadres in the field.
4. All interviewed organizations were compelled to employ a non-Bahraini GIS cadre because of the severe lack of qualified national supply.
5. The knowledge level of the great majority of GIS operators is confined to the technical side, with little or no theoretic geographic knowledge to help in analysis and deducing solutions to problems through spatial reasoning.

As it is commonly the case with technology in general, GIS is changing rapidly in response to changes in data techniques, handling and characteristics. Expectedly, the job market responses in a highly elastic manner to technology changes. In theory, similar dynamism is required for educational programs to cope, but in practice, however, the situation cannot be as simple as that, as a higher degree program cannot be changed on a semester base. Yet, the internal dynamism in the AGGIS individual course descriptions is flexible enough to accommodate updates of material and teaching instructions as the situation necessitates.

CONCLUDING REMARKS:

The design of academic programs with a highly technological element in their curriculum is not a simple job. The success of any GISc curriculum rests on many factors: a proper methodology for its design, its scientific contents, the relevance of such contents to the local circumstances and, finally, a consideration of the fact that GIS is not only taught, but also taught to students with a wide variety of abilities. Indeed there is no single 'best' answer to the question of design, either for the curriculum itself or for the methodology adopted for its design.

The focus of AGGIS is the science of geography, spatial analysis and both the technology and science of geographic information systems. The program course modules are structured to provide professional education in a multidisciplinary fashion, covering wide areas of information technology, geographic information systems, location-based services, database systems, mapping science, remote sensing, visualization, statistics and spatial analysis. With this focus, it should produce geographers with strong specialty in GISc. The main theme of the program is centered

on the close relationship that ties GIS toolbox to the discipline of geography with its spatial reasoning emphasis within the holistic approach of geography. It has been said that the map is the primary input to GIS and it is often the final output. But what map is AGGIS all about? The program considers mapping within the new spatial paradigm which rests on spatial reasoning, which in turn, no longer deals with maps as containers of spatial data, telling just where things are. Rather the new spatial paradigm looks at how a number of different maps can be combined to provide insights into how things could be, and accordingly, produce what is really needed. Thanks to GIS, this analysis process has, by virtue, become an independent operation of any specific application.

Finally, it may be claimed that AGGIS was designed and implemented hoping to change the local view of the discipline of geography as a non-useful one in today's circumstances; a view that is shared in the Arab World, and perhaps elsewhere in the third world. To what extent did AGGIS succeed in achieving this objective? It remains to be seen.

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