SYMPOSIUM ON GEOGRAPHIC INFORMATION SYSTEMS: LOCAL LABOUR MARKET INFORMATION SYSTEM: GIS IN BELFAST

DEREK BOND*, MARK HART** AND PAULA DEVINE
Northern Ireland Regional Research Laboratory

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1. INTRODUCTION

The evolving urban systems within the United Kingdom have attracted considerable attention, in particular, the changing geography of manufacturing industries at the region/urban level during a period of decline at the national level. The growth in outer metropolitan areas and smaller towns has helped compensate for the decline in inner cities and conurbations. This has resulted in both detailed studies of these trends and a series of initiatives in response to the restructuring process. Within Northern Ireland what are euphemistically called the 'troubles' have led to an another area of study: the relationship between the sectarian divide, employment opportunities within the manufacturing sector and the evolving policy context. These developments require a readily accessible, reliable and relevant local labour market information system which facilitates the effective analysis and monitoring of the situation. This paper looks at whether these requirements can be met using the technology of Geographic Information System (GIS) as exemplified by the work conducted on industrial and employment policy in the Belfast labour market by the Northern Ireland Regional Research Laboratory (NIRRL).

* Ulster Business School, University of Ulster
** Northern Ireland Economic Research Centre

2. THE CHANGING GEOGRAPHY OF MANUFACTURING INDUSTRY AND RESPONSES

Since the mid-sixties there has been a major shift in the importance of manufacturing industry within the United Kingdom economy. This reworking of the manufacturing economy at the national level has gone hand in hand with a reworking of its urban and regional geography. Of particular importance have been the changes that have occurred at the sub-regional level. The decline of the inner cities and the conurbations and the relative growth of outer metropolitan areas and smaller towns represent the most significant shift in the geography of manufacturing since the mid-1960s (c.f. Fothergill and Gugdin (1982) and Massey (1989)). Indeed, as Fothergill et. al. (1986) state:

> *"The industrial city in Britain is the product of nineteenth-century capitalism...", but, "all this has changed... there has been a complete turnaround in the fortunes of the industrial city: in the late twentieth century the city is the principle location of deindustrialisation."*

The economy of Belfast mirrors very dramatically this generalised view of urban employment change in the U.K. since the mid-1960s, as the old manufacturing bases of shipbuilding, engineering and textiles have declined, as new industries have been established but often at different locations within the city region from those occupied by the old industries, and as employment in service industries has grown substantially. The impact on the labour market of these broad trends has been severe with rising unemployment the most visible feature: in March 1990 there were 18,906 unemployed persons in Belfast District Council Area. Furthermore within this area the distribution of unemployment is not spread evenly within localities, in particular West Belfast, which registers unemployment rates which are nearly three times the regional average. Clearly the growth in employment that has taken place in the service sector has been unable to compensate for the collapse of employment in the manufacturing sector.

Nationally, as a direct result of these emerging trends in sub-regional employment, two parallel developments have taken place in the 1980s. First, a large number of studies into the dynamics of local economic restructur-

ing have been initialised. A particular feature of these studies has been the development of a 'locality-focused' method of analysis. The Economic and Social Research Council (ESRC) sponsored initiatives on the 'Changing Urban and Regional System' and the 'Inner Cities Research Programme' are prime examples of this changing emphasis (Boddy, 1987). Second there has been an introduction of a plethora of new initiatives by both central and local government designed to respond to the problems of the local economy. The development of economic and employment strategies by local authorities to combat restructuring processes has been a central feature of these initiatives (Cochrane (1988), Lovering (1988)). The monitoring of these policy initiatives has become an extremely important dimension of local economic development in the 1980s.

A key feature of this new type of local economic strategy is a detailed understanding of the local labour market characteristics and dynamics, which necessitates the availability of the appropriate data and, more importantly, depends upon its accessibility. Also the amount of public monies being committed to the general problems of urban regeneration clearly reflect the need for an accurate and effective information system which can be used as a basis for policy decisions and evaluations.

3. LOCAL LABOUR MARKET ANALYSIS

As Haughton and Peck (1988) have outlined, there are a wide variety of secondary data sources available which provide relevant information on the local labour market. These include NOMIS, CALLMI and other data sources held by or in conjunction with the MSC. They argue that while these data sources provide useful information on the structure and dynamics of the local labour market, they do not identify at a finely disaggregated level the exact nature of the 'rigidity'. Therefore, from a policy viewpoint these sources are not particularly helpful in identifying the specific measures required in any local area, although they can be used very effectively in the monitoring and evaluation of policy measures at the local level.

Consequently, local skill audits have emerged as an important dimension to any local economic development strategy. Skills audits involve wide-ranging research into the skills profile of an area and seek to address the issue of local skill mismatches and try to identify ways in which these can be overcome. In particular, the audit focuses upon employees, individuals

(employed and unemployed) and the local training infrastructure within a particular area. Those conducted in Britain have varied in scope from a survey confined to an individual housing estate to one encompassing whole cities. The primary data produced by these skill audits provided a great degree of 'value added' to existing sources.

Thus in response to an increasing demand by researchers and policy-makers a great deal of information is being collected on the local labour market. The question with which this paper is concerned is whether GIS has a role in making this information available to a broad client group responsible for the design and delivery of urban employment policy? From the definition of a GIS given in the Chorley Report on Handling Geographic Information:

> *"A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced"* (HMSO (1987) p.132)

this would appear to be the case. In Northern Ireland the 'troubles' and the associated segregated labour markets have led to additional information requirements which seem especially suited to a GIS environment. This paper will concentrate on the Belfast Urban Area which, as explained in the next section, has experienced some of the worst effects of economic restructuring.

4. JOB GENERATION AND URBAN POLICY IN BELFAST

The economic context of the Belfast region has changed significantly over the last two to three decades in terms of industrial structure and patterns of employment. As a result there has been a sharp rise in the level of unemployment in the city, which in some localities such as West Belfast has risen to around 40% (NIHE (1985)). Since the early 1980s there has been a plethora of specific policy instruments focused on the specific economic problems of Belfast. These have been implemented in addition to the wide range of activities undertaken by the industrial development bodies and local enterprise agencies in Northern Ireland. Such polices include Enterprise Zones, Integrated Operations, the Local Enterprise Programme, Making Belfast Work and the Belfast Urban Plan.

As in the case of regional policy in the 1970s, urban policy in the 1980s faced the overriding problem of a national economy in recession. Accordingly, the impact of urban policy was always going to be influenced by the policy adopted for the management of the national economy (Lever and Moore (1987)). Even at the end of the 1980s when the national economy is supposed to have witnessed an 'economic miracle', the visible evidence of that recovery seemed slow to reach many parts of the U.K. space economy, and in particular inner city localities. One such inner city locality in the context of Northern Ireland is West Belfast.

Within West Belfast there has been a wide range of local community initiatives emerging in recent years in an attempt to create employment opportunities (Rolston and Tomlinson (1988)). Some of these have been co-ordinated through the Government's Local Enterprise Development Unit's (LEDU) Local Enterprise Programme, others are emanating from the voluntary sector, community groups and the churches.

In addition the Action Team Initiative of 1987 administered by the Department of Environment through the Belfast Development Office, is designed to bring about an improvement in the quality of life and an enhancement of the opportunities and prospects of people living in areas of multiple social and economic deprivation through an area based strategy. The initiative has four main objectives: employment provision; improved employability; improved co-ordination; and delivery of public services and community improvement. There are eight action teams (commonly referred to as BATS) operating in Belfast.

Furthermore, the recently established West Belfast Enterprise Board seeks to advance a more strategic position on local economic development. However, at the moment the lack of coordination between these initiatives is perhaps a debilitating factor in their development. In that respect the announcement in 1988 of a £65 million 'aid package' over three years by the Department of Economic Development, and also the commissioning of a number of studies into the development of policy instruments is a welcomed, if belated, attempt to instigate a coordinated policy response.

However, urban analysis in Belfast in general is complicated by a sectarian divide which has effects on the whole sphere of life. Any kind of local labour market analysis needs to take this into consideration. This can

complicate even what is apparently simple analysis. For example under the Fair Employment (NI) Act 1989 the Fair Employment Commission are required to monitor the religious composition of all workforces to ensure fair participation rates. Determining what are fair participation rates obviously requires the definition of catchment areas for workplaces. Such modelling in NI is complicated by the existence of peace lines and other more subtle sectarian divides which can be viewed as perceived.

Whether it be an evaluation of Enterprise Zones, Integrated Operations, the Local Enterprise Programme, BATS, Making Belfast Work, the Belfast Urban Area Plan or the monitoring of the new Fair Employment legislation the value of disaggregated labour market information cannot be overstated. At a very basic level it assists in the process of coordination between Government departments and agencies charged with the responsibility for urban policy. However, more importantly, such a local labour market information system would greatly assist in the process of carefully targeting areas and communities most in need of support. To date, the major problem facing the coordinators of particular policy initiatives is the unsystematic nature of the way in which key information is gathered, stored and accessed. It would appear that GIS technology, based on high quality local labour market data, offers an important opportunity to serve the urban policy debate. To illustrate this the next section considers how GIS could be used by the Client Executive of LEDU.

5. PUBLIC POLICY: AN APPLICATION OF GIS

The role of the Client Executive in LEDU - the Northern Ireland small firm agency - is the important one of forming a bridge between new and existing client companies and the specific policy measures of the agency. Generally, the task of the Client Executive is to provide a point of contact for small companies and individuals seeking grant assistance and advice from LEDU. The subsequent evaluation of any application for financial assistance is conducted by the Client Executive in conjunction with other technical staff within the agency.

Initially the evaluation procedure of each application concentrates on some very basic questions which address issues such as the number of existing LEDU clients in the specific industrial sector, geographic area and how they have been previously funded (if applicable). Such issues are important

in the general displacement argument associated with a great deal of new forms of economic activity at the local level irrespective of whether they have been assisted by Government. Answers to these questions are argued to be central to the Client Executive's early appraisal of an application, yet how is the information currently assessed? Quite simply, the dependence upon manual file systems and recall drive the response to these questions.

Clearly, a GIS-based local labour market information system, which permits the identification on screen of all existing LEDU clients in the local area from which the individual project application derives, greatly enhances the ability of the Client Executive to provide a speedy appraisal. Furthermore, the local labour market information system should also provide the Client Executive with individual details on all those companies not assisted by LEDU in the area, but who may also obviously form the potential competition for a new or existing client seeking financial assistance. Within the context of the Belfast labour market the problems of segregation which affect West Belfast in particular have increasingly caused the industrial support agencies a great deal of discomfort. The question is often posed of LEDU and their Client Executive - what are they doing to counteract the economic malaise of that local area.

Surprisingly LEDU found it extremely difficult to answer that question in the summer of 1988 when the 'Making Belfast Work' campaign was announced. The problem was the total absence of any adequate spatial referencing of their own data which would quickly permit that level of local disaggregation. Once again, a GIS-based local labour market information system should facilitate an understanding for the agency of its past role in any given local area. More importantly, it should provide a framework for the future monitoring of its role in an area such as West Belfast.

Returning to the Client Executive, the availability of this GIS-based system would enable project appraisal to become spatially discriminatory in favour of areas such as West Belfast. Thus, instant on-line access to the system would provide the Client Executive with an invaluable tool with which to assist in the implementation of strategic organisational goals at an individual project level. Finally, the addition to the information system of detailed community skills audits would provide the Client executive with a source of invaluable on-line information on 'needs assessment' within local areas.

To summarise, a GIS based local labour market information system would provide the Client Executive of LEDU with an effective and efficient method of discharging their role in the development of the urban economy. Clearly if such a system is to be developed there is the need for high quality, relevant and spatially disaggregated datasets. Those available to the NIRRL will be discussed in the next section.

6. AVAILABLE DATASETS

The NIRRL have access to two high quality, relevant and spatially disaggregated datasets: The Northern Ireland Economic Research Centre's (NIERC) Manufacturing Establishment database and the Queen's University of Belfast, School of Geosciences' holdings of the 1971 and 1981 Census of Population for Northern Ireland. These two databases will soon be supplemented by data from the Ordnance Survey for Northern Ireland's digital topographic database.

The NIERC Manufacturing Establishment database currently contains information on 4461 establishments which exist or have existed between 1973 and 1986. The data on each establishment includes: name and address; industrial activity (4 digit MLH - 1980); annual employment since 1973 (normally June each year) for most establishments, except the very smallest; details of ownership; birth and closure dates; indication of move to Northern Ireland from outside; Government assisted status (i.e. IDB or LEDU assisted firms) and grant assistance received (since 1981). For the Belfast Urban Area (Belfast, Castlereagh and Newtownabbey District Council Areas) the database holds 1009 records.

The data has been collected from a variety of sources including: the Industrial training Executive, Health and Safety Executive, Cabinet Lists compiled by the Department of Economic Development, LEDU, IDB Trade Directory and 'Who Owns Whom'. Comparisons with the Census of Employment for Northern Ireland reveal that the database represents a comprehensive coverage of manufacturing employment at regional and sub-regional levels. Therefore the NIERC database goes further than the nationally available NOMIS data by providing important enterprise data for labour market analysis. As a result the characteristics of local labour market dynamics can be more clearly revealed.

For this data to be used effectively in a GIS system it must be accurately spatially referenced. This has been done by using both the Department of Manpower Services (now part of the Department of Economic Development) Geocode Index and the Northern Ireland portion of the POSTZON file. The Geocode Index was compiled during the late 1970s and was originally used by DMS to attach a spatial reference to all data units entering the Department. Unfortunately the software needed to fully utilise this information was not available at that time. Therefore, given the considerable cost involved in its compilation and the apparent lack of relevance, the decision was made to move to using Postcodes when a spatial reference was necessary; subsequently the directory has not been updated for over ten years. The directory gave an Irish Grid reference for each address in Northern Ireland. These were at 100 metres resolution for Belfast and parts of Londonderry and at 1 kilometre resolution for the rest. The POSTZON file for Northern Ireland only became available in the mid 1980s. It gives for each Postcode a spatial reference as well as allocating it to various administrative districts. It has the same resolution as the Geocode Index and seems to have been constructed form it. Using these two sources it was possible to cross check the spatial information in the database.

Data on manufacturing establishments only provide a partial picture of the demand side of any local labour market. Data is clearly required on a similar basis for other sectors of the local economy. Such data is currently not available at regional or sub-regional level in Northern Ireland.

Turning to the supply side considerations in the labour market, the NIRRL has access to the 1981 and 1971 Census of Population for Northern Ireland. Due to differences in the legal and administrative arrangements in Northern Ireland, these holdings allow for a much more flexible retrieval of information than is possible using systems such as SASPAC for the rest of the UK. Clearly the Census of Population information falls some way short of the quality of data contained in the 'Skills Audit' outlined above. Nevertheless it does provide an important profile of the basic population characteristics of any local labour market, and is at the very least a basic supply-side input into any strategy for local economic development. Unfortunately the coverage of the 1981 Northern Ireland Census of Population is incomplete. Due to political protests at the time there was a partial Republican (Catholic) boycott.

A third database is only now becoming available to the NIRRL and as yet has not been used but in the long run could prove to be its greatest asset. This is the COMTOD database being developed by the OSNI, which is a digitised topographic database based on the OSNI base maps. By 1996 all of Northern Ireland will be covered by the database. The facility built into the database will allow the NIRRL to identify any establishment or other topographic feature by its 12 digit Irish Grid reference. There are over 100 difference hierarchical levels of information available and updates to the system cause the older data to be archived. Thus not only will the NIRRL have access to up to date on-line digital topographic information, but also to an historic time-series. Thus physical changes in establishment (e.g. construction, alteration, demolition etc.) can be recalled.

7. THE STRUCTURE OF THE NIRRL LOCAL LABOUR INFORMATION SYSTEM

The requirement then is to provide an effective and efficient method of storing, retrieving and analysing this data. For this the NIRRL has attempted various possible hardware/software combinations. As with the other RRL the NIRRL has been provided with the PC-ARC/INFO GIS, the PC-MAPICS and PC GIMMS cartographic packages.

The pilot local labour market information system was developed using these packages on an IBM PS/2 model 80, loaned by IBM as part of a study contract into the use of PS/2s as GIS workstations. The structure of the information system was to use PC-MAPICs to provide a menu driven series of choropleth and point maps and time-series graphics of the two databases and of published socio-economic and demographic statistics. GIMMS was used to provide high quality cartographic output. The main module of this pilot system was built around PC-ARC/INFO using the ARC/INFO's SML macro language. This module allowed for a WIMP type interface to be developed, so that the data in question could be overlayed on topographic details, such as roads, ward boundaries etc., and then textual values could be requested from the INFO database. This system allowed for quite complex queries on the database. For example, using the menus a map of West Belfast could be drawn and the location of all firms in a particular industry plotted out. Details on individual firms can then be obtained by pointing at the location on the map.

On inspection this system seemed to be extremely weak in the most crucial part of a GIS, the Database Management System (DBMS) used. For the full potential of a GIS to be realised the underlying database must allow for various access routes to the data and various methods of retrieving data. For maximum flexibility the DBMS should be relational but allow for hierarchical and network structures. It should be capable of importing data from many different sources and be capable of retrieving data in formats which can be used directly in other packages with minimum duplication of effort. The link written by ESRI, the suppliers of ARC/INFO, between ARC and the INFO database means that many of these requirements are met for the topographic data. Unfortunately, INFO and ESRI's extensions fall short when the attribute data is considered.

Therefore, the NIRRL adopted the strategy of using ARC/INFO for the main storage of topographical data and the DBMS SIR Version 2.2 for the attribute data. Subsets of attribute data could then be transferred from SIR to the ARC/INFO package. The decision to use SIR was a pragmatic one - it was readily available, most official socio-economic datasets in Northern Ireland and many datasets at the ESRC data archive are stored in SIR format; there is considerable expertise in its use available locally; and the 1981 Census of Population, the NIERC Manufacturing Establishment database and the Annual Census of Agriculture for Northern Ireland are held in SIR format by the NIRRL. With version 2.2 of SIR a fully relational database structure is possible, though a case structured subsystem can be retained. Research within the NIRRL on a multimodel DBMS using SIR 2.2 (c.f. Larson (1983)) has shown that such models offer efficient storage and retrieval characteristics in excess of those offered by just relational or case-structured data models. Finally, SIR 2.2 allows for the transfer of data to most of the main statistical packages (i.e. SPSS, SAS, CLUSTAN etc.) without loss of information - i.e. the data dictionary is copied over as well.

A second approach of the NIRRL is to use the SIR databases directly using the SIR/HOST FORTRAN subroutines and the UNIRAS graphics library. This system, running on a VAX 8700, has the advantage of speed, flexibility and access to a full database management system. Extensions which have been made possible by this method are those of interpolation of employment surfaces, prismatic mapping and direct links to major statistical packages.

A third approach has been to use the OS/2 operating system: this contains its own WIMP and graphics environment, Presentation Manager, and own SQL-based database, Database Manager. These can be accessed by the user through a language such as C. The advantage of this approach is that the user is presented with a standard interface and the system does not depend on expensive third party software.

8. THE POWER OF A GIS

While the interactive, graphical interrogation of a complex spatially referenced dataset is interesting and appealing it is difficult to argue that this is enough to justify the considerable investment required to move from a DBMS based system to a GIS system. For example, using the ARC/INFO based NIRRL Local Labour Market Information System it is possible to retrieve details of factories in a area that fulfil certain criteria and merge this information with basic demographic/skill information. The data can then be displayed in map form. Clearly an alternative route would be to used a standard language such as SQL to relate the two datasets together and to search under the given criteria. The retrieved data could then be displayed as a map if required using a standard cartographic package. For the extra overheads of using a GIS to be justified more than just the ability to retrieve and display spatially referenced data must be offered.

Some of the issues raised by the Fair Employment Act (NI) 1989 illustrate areas where a GIS has additional power over a tradition DBMS. One such problem is what is the 'correct' ratio of Protestants to Catholics in a workplace. To investigate this problem one has to establish what the ratio is for the eligible population of working age in the establishment's catchment area for each skill level. One way of obtaining this underlying figure would be to consider the data on religious affiliation for all minimum spatial units within a certain radius of the workplace. Even if one allows different radii for different groups of workers such an approach fails to take into account the underlying topology of the area. That is, natural travel routes and barriers are not taken into account. Within a GIS it is possible to attempt to model these factors and provide a decision making framework.

From the 1981 Census of Population it is possible, for each minimum spatial unit, to obtain details of the socio-economic structure of the pop-

ulation, the normal means of transport to work, the normal journey time etc. grouped together as required. Unfortunately the coding of workplaces in the 1981 Census of Population for NI was only District Council Area so it is not possible to obtain details of sub-DCA travel patterns from this source. Using ARC/INFO it is possible to attach to all topographical features which represent transport routes various impedances representing the ease with which it is possible to traverse this feature. For example when roads are digitised into ARC/INFO they have their lengths, in map units, stored in the topographic database; if one assumes a certain walking speed, it is easy to calculate and store in the database the time it would take to walk each individual section of road. Thus, transport networks for various modes of travel can be constructed.

The modelling of the underlying catchment area for a workplace using ARC/INFO consists of using the data derived from the Census on the travel characteristics of different skill groups to find out from where that group would travel to the workplace. Using the impedances built into the topographic data ARC/INFO will work backwards from the workplace to find out the limits of travel. For example, if messengers usually travel on foot to work and have an average journey time of only ten minutes then ARC/INFO will work outward from the workplace and select all parts of the transport network which are within ten minutes journey time. This network can then be overlayed on the Census of Population data and a ratio for the number of Protestants and Catholics obtained.

At first sight it would seem that such a method would allow for the introduction of a black box approach to deriving the required ration but this is not the case. There are many problems with the technique still to be solved. For example, what figures are used to derive the average journey time and method of the skill groups? It is unlikely that these will be homogeneous for Northern Ireland or even for smaller spatial units. What are the correct underlying groups to use to obtain the ratios? Is it only those in the same socio-economic group who are economically active? Other problems concerned the reliability of the data. The religious affiliation question on the 1981 Census of Population for Northern Ireland was not compulsory and there was a boycott of the whole Census by certain political groups.

Apart from the general methodological problems such considerations throw

up there is also the problems generated by the sectarian divides. A simple transport network model which allows only for impedances based on distance and physical impediments would fail to model effectively the actual transport network of a divided community such as Belfast. For example the inner-city areas of the Lower Falls and the Lower Shankill are adjacent to each other. The first is nearly 100% Catholic and the second 100% Protestant. For part of the boundary between the two areas there is a physical wall - normally known as the 'Peace Line' but in parts main roads cross from one area to the other. The question then is, how does one model such a situation in a transport network? The problem is that while it is unlikely that workers from the lower skill levels, travelling on foot or by public transport from either area would travel to the other, it is possible that managers etc. using cars would. More difficult still is the problem of workers of either denomination who would need to travel through one or both of these areas to get to their workplace. At present, reliable data does not exist which would allow for the development of a network which would take such factors into account. Work in the NIRRL is underway to investigate the whole area. Whether it would ever be possible to model such a complex situation is questionable. Thus it is likely that while the method can be developed and refined it will always just provide a framework for analysis rather than a complete solution.

Despite these shortcomings the problem of defining catchment areas illustrates clearly a possible advantage of using a GIS rather than either a DBMS or a transportation model in isolation. It allows the user to integrate spatially referenced data and analyse it in a spatial framework. Going back to the requirements of the Client Executive of LEDU, this ability to model both the topographic and demographic features of Belfast would allow them to more effectively define the spatial areas of interest when attempting to model the impact of investment decisions.

9. DEVELOPMENTS

The NIRRL is committed to the continuing development of the Local Labour Market Information System. Central to this work will be the linking of the Information System to the OSNI COMTOD data. The development of the National Transfer Format (NTF) should provide the facility to transfer topographic data from the OSNI database without loss of information.

The continual development of the transport network model for Northern Ireland is also a high priority. Such a model is not only important for modelling travel-to-work patterns but also for reviewing the whole question of the provision of transport services. Such questions as whether it is more difficult for Catholics to travel to places of work need also to be considered. The policy of trying to force employers to local factories in certain unemployment blackspots has been a failure. Thus the policy of trying to make it easier for workers to travel from these areas to workplaces could be tried.

As the system is developed the question of confidentiality of information will play a larger role. The Chorley Report recommended that a highly detailed method of spatial referencing is to be preferred. While this might be used as a basis for storing data the GIS system will need to be able to allow the data to be retrieved only in larger spatial units which retain the confidentiality of the suppliers of data.

10. CONCLUSIONS

This paper, by looking at the requirements of a local labour market information system for Belfast, has highlighted one of the main advantages of a GIS: the ability to overlay various spatially referenced datasets and to analyse them in a spatial framework. This application of GIS, as with most others, relies mainly on a 'Kepler' type approach. For GIS to develop into a mature subject a 'Newtonian' approach also needs to be developed.