An Evolutionary Framework for Strategies of Spatial Technologies: Case Study Analysis

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ABSTRACT

An evolutionary framework is presented for spatial information technologies in business. The framework has the three dimensions of extent spatial applications are customer-facing, the extent geography influences the business, and the extent of presence of spatially-enabled web integration platform versus traditional spatial platform. The evolution of the framework over time is towards more customer-facing, greater extent of geography in the business, and greater extent of spatially-enabled web integration platforms. The framework is tested by interviews of eighteen case study companies that vary in size and industry. Case study methodology is utilized. The research question asks whether strategic spatial focus is related to one or more of the framework dimensions. Results indicate that greater strategic focus of a company is associated with increases of spatially-enabled web integration platforms, but not with extent of geography in the business or with the extent spatial applications are customer-facing. The findings are compared to literature on frameworks of classifying spatially-enabled firms.

Keywords: Spatial technologies, strategic, framework, case study.

1. INTRODUCTION

Spatial technologies and geographic information systems (GIS) grew up in government (Longley et al., 2005), but have moved rapidly in recent years into the business sector (Francica, 2005). A few studies focusing on business spatial uses have emphasized the strategic aspects. The framework of Ghosal (1987) has been useful to understand IT strategy, and was extended to GIS in business (Murphy 1996). Ghosal pointed to three areas of strategic goals: efficiency in current operations, managing risks, and learning, innovating, and adapting. All the areas carry over to GIS strategies (Murphy 1996). Likewise, Ghosal's three areas of IT strategic tools (economies of scale, economies of scope, and exploiting factor differences) can apply also as GIS strategic tools (Murphy 1996.) A contributor to the goal of learning, innovating, and adapting is "organizational memory and learning" (Ghosal 1995). For spatial applications, GIS mapping and analysis can consolidate memory visually, reduce the complexity, and make learning easier. GIS can help an organization achieve its vision and strategic goals (Tomlinson 2003).

Use of these technologies is growing rapidly, including in the business sector. Daratech estimates that the market of core software and services for GIS was $1.7 billion in 2003 (Daratech 2004), while Longley et al. (2005) estimate the total worldwide expenditure on GIS and related activities is $15-20 billion.

The trend for spatial technologies in business has been to extend them from traditional GIS systems to enterprise-wide systems that run on web-based architectures (Sonnen and Morris 2005; Guerrero, 2005). A traditional GIS system refers to powerful desktops or client-servers running GIS commercial software. It has powerful functionality and requires geographic and GIS expertise to develop. The enterprise-wide systems tend to run under spatial web services architecture, which consists of servers connected to the web that provide spatial applications to web-connected clients. Also, enterprise servers such as those from ERP, CRM, and Business Intelligence can be connected to this web architecture. For instance SAS, a leading business intelligence vendor, has achieved tight integration of its server-based software to the server versions of ESRI's GIS software (Barnes 2005).

The objectives of this research are the following: (1) develop a conceptual framework of the evolution of spatial technologies in business, that takes into account how customer-facing the application is, how geographical the industry or firm is, and the extent the industry or firm uses a spatially-enabled, enterprise-wide integration platform, (2) analyze eighteen case studies of businesses and classify the cases in the framework, (3) analyze how strategic are the spatial applications for the case companies, and (4) answer the research question of whether the level of spatial strategy of firms is associated with dimensions of the framework.

The paper's *Research Question* is as follows: Is the extent that a company is strategic in its spatial technologies in year 2005 associated with one or more of the three dimensions in the evolutionary framework: the extent applications are customer-facing, extent the firm is geographic in its business, and/or extent the firm uses a spatially-enabled, enterprise-wide web integration platform.

The study is exploratory and utilizes qualitative, case-study methodology. Its goal is to raise issues of emerging spatial technologies for business and to gain understanding through exploratory analysis of case studies. The study is not intended to be statistically significant or to confirm research questions based on a large sample.

2. METHODOLOGY

The methodology for this research is case study (Yin 1993, Yin 1994). The case study strategy consists of definition of the study focus, framework construction, interviews, data collection, and case analysis. Case studies are often used to deepen insight into enterprises and their decision-making processes, sometimes more so than can be done with large sample surveys (Yin 1994). Case study investigation often has small sample sizes (Yin 1994). The present case study sample was determined by selecting eighteen firms, each in a different industry that is known to utilize GIS (see Table 1**).** The sample of firms is not randomly chosen, but is a convenience sample**.** Five of the industries were ones with high spatial technology use (oil and gas, utilities, retail, environmental services, and transportation) and seven were ones with moderate spatial technology use (banking, health care, marketing/advertising, newspapers, publishing, consulting, and consumer services). The firms were selected to have different size categories (6 large, 3 medium, 2 small), ownership structures (3 are private, 8 public), and corporate structures. The range of firms is broad in order to encompass a variety of spatial and strategic factors and to demonstrate a range of firms for the evolutionary framework. For each firm, the protocol is to interview the manager or executive responsible for spatial technologies. For one firm, that responsibility was split evenly between GIS technology and GIS marketing so both managers were included in the interview. The interviews utilized a standard interview protocol and set of general questions. They were transcribed in writing and tape recorded if permission was granted. The interview transcripts were sent to the interviewees for factual corrections. Secondary materials on spatial technologies in the firms were requested, and provided by most firms. They consisted of company reports, postings, and writeups. In addition, secondary business materials were obtained from company websites and standard business information services (Dun and Bradstreet 2005; Hoover's, 2005; Standard and Poors, 2005).

Responses to specific items on the interview protocol were used to position the company in the framework, in particular extent spatial is customer-facing; extent spatially-enabled, enterprise-wide web integration platform; and extent of geog-

Table 1. Sample of firms for case studies

Name or description	*Industry*	*Size*
Global Integrated Oil (description)	Oil and Gas	large
Kaiser Permanente	Heath Care	large
Large Credit Bank (description)	Banking	large
Large Commercial Bank (description)	Banking	large
Rand McNally	Publishing	large
Southern Company	Utilities	large
Sears Roebuck	Retail	large
URS	Environmental, Planning	large
Norwich Union	Insurance	large
Lamar Advertising Company	Marketing/Advertising	medium
Arizona Republic	Newspapers	medium
Western Exterminator	Environmental Services	medium
Bay State Health	Hospitals, healthcare	medium
Sperry Van Ness	Commercial real estate	medium
Prudential Preferred Realty	Residential real estate	medium
Engineering Systems	Consulting	small
Motion-Based Technologies	Consumer Services	small
MapGistics	Consulting for Hospitals and Healthcare	small

raphy in the business. The latter refers to how important geographically-based products and services are in the firm.

3. EVOLUTIONARY FRAMEWORK OF SPATIAL TECHNOLOGIES

This section proposes an evolutionary framework that takes into account three key dimensions. Since GIS and spatial technologies are new to the business research few frameworks or theories have been proposed to account for their evolution and growth (Hackbarth and Mennecke 2005; Jarupathirun and Zahedi 2005).

A prior "geo-business application model" (Hackbarth and Mennecke, 2005) categorized geo-business applications by three dimensions: (1) type of agents (virtual, digital, physical), (2) type of products (virtual, digital, physical), and (3) type of processes (virtual, digital, physical). This model focuses on these virtual typologies, but does not take any account of the organization. The unit of analysis is the application. Another study considered a model of web-based spatial decision making where a variety of expectations led to perceived goal commitment and perceived task-technology fit, leading in turn to performance measures of spatial decision support systems (Jarupathirun and Zahedi 2005). The present paper's framework recognizes the whole industry or firm as the unit of analysis. No prior firm-level or industry-level conceptual models have appeared in the research literature for spatial technologies.

The present evolutionary model was developed by consultation with industry experts and by scrutiny of industry literature (Tomlinson 2003, Barnes 2005, Guerrero 2005, Maguire 2005, Reed 2005, Sonnen and Morris 2005) and several academic sources (Francica 2005, Lopez 2005). The model is a theoretical one that is based on three model dimensions that were repeatedly emphasized by the experts and the literature. The dimensions are: (1) extent that spatial applications are customer-facing, (2) extent that geography is part of the industry or business, and (3) extent that the industry or business utilizes a spatially-enabled enterprise-wide integration platform. The configuration of them into a three-dimensional space for categorization was the original work of the author, but was suggested by a three-dimensional categorization model for location-based-systems (Hackbarth and Mennecke 2005). There are numerous 2-D and 3-D categorization models in the IT field. The first dimension consists of the extent that spatial applications in the industry or company are directed towards a user base that is predominantly customers (i.e. customer-facing) versus spatial applications that are directed towards internal users. Internal users include executives, managers, marketing specialists, middle-level analysts, operations personnel, sales force, and field workers. Spatial applications at outsourcing providers that are closely associated with a firm are considered "internal," rather than customer-facing.

The extent of geography as part of the business refers to whether the major business products and processes relate closely to geography. An example of an industry closely linked to geography is transportation, for which the key processes of moving goods and services are inherently tied to geography; another example is the utility industry, for which the products of energy, purified water, and essential materials are provided through geographical network routing of transmission lines, pipelines, and specialized transport vehicles. Real estate is another obvious example, with land as its central element. On the other hand, the legal services industry has slight linkage with geography for its essential products and processes. Another less geographically-tied industry is financial services, since its vital products and services are not usually strongly linked to geography. In between in spatial intensity are industries such as health care, banking, metals manufacturing, and pharmaceuticals.

The extent that an industry or business utilizes a spatially-enabled web integration platform refers to whether it is based on "traditional" desktop or client-server spatial applications or is mostly based on the web-based and location-based enterprise architecture that consists of web servers, content servers, the web, thin and thick clients (Barnes 2005, Guerrero 2005, Lopez 2005, Maguire 2005, Sonnen and Morris 2005). Sometimes spatially-enabled portable mobile devices are included in this architecture by GPS and/or wireless links. In between are mixed architectures, in which industries for companies depend substantially on a mixture of the traditional technical GIS platform and the emerging web- and location-based integration platform.

The changes in the evolutionary framework over time are shown circa 1995 in Figure 1, and in 2005 in Figure 2. Figure 1 only shows two dimensions, since the spatially-enabled web integration platform was not present, but only the traditional desktop or client-server. Geography-tied industries such as transportation and utilities are shown with higher values on the x axis while ones with much less spatial linkage such as steel and private hospitals have low values. On the y axis, industries that are not customer-facing in spatial technologies include pest management and oil and gas, while industries such as real estate are moderately customer-facing, but no industries in the mid 90s are highly spatially customer-facing. The deficit of high customer-facing is because map delivery was still cumbersome, bandwidths were not high enough for effective interactive mapping, and businesses mostly had not yet recognized the benefits of providing maps and spatial analysis to customers.

In 2005, the complexion of industry distributions changed, and the web integration platform appeared, so it is added to the framework as the z dimension. Compared to 1995, there are only moderate changes in some industries with respect to ex-

Figure 1. Evolutionary framework of industry categories by two spatial dimensions, 1995

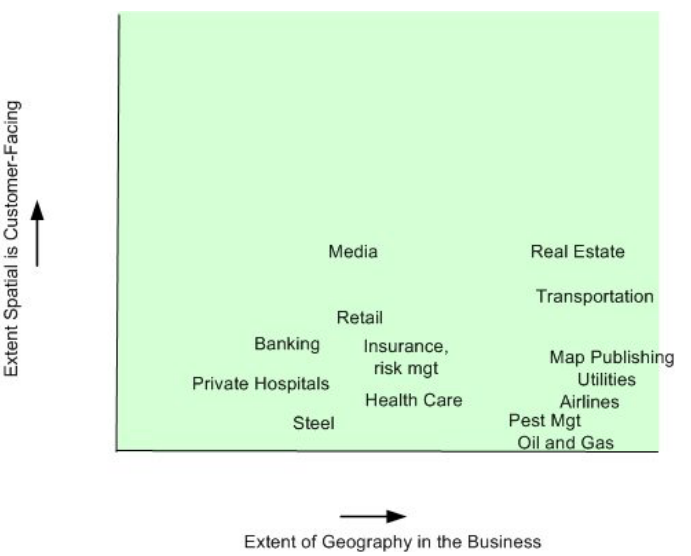


Figure 2. Evolutionary framework of industry categories by three spatial dimensions, 2005

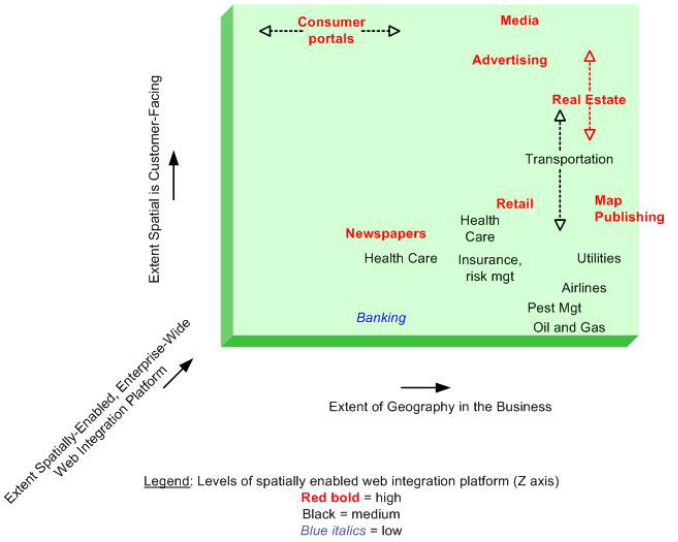
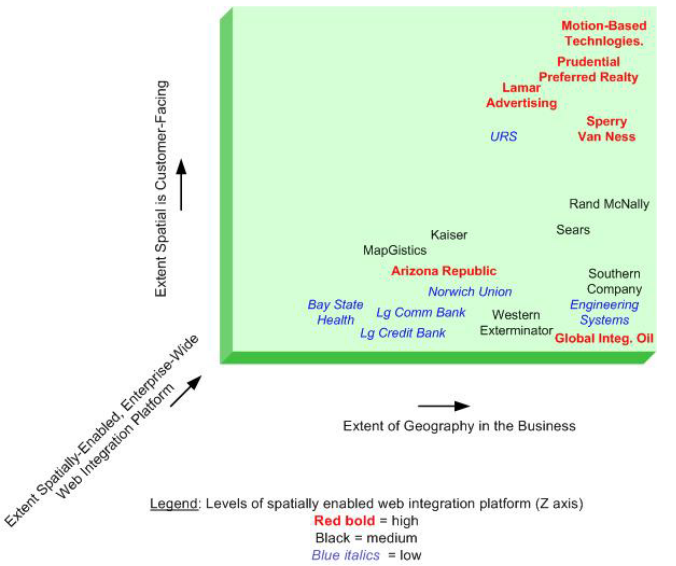


Figure 3. Evolutionary framework of industry categories by industry cases, 2005



tent of geography in the business. These changes arose because some industries became more geographical. For instance, as banks consolidated and covered larger territories, some of their geographical-based functions, such as real estate and marketing, gained in importance. Likewise for private healthcare, the larger chains created through mergers and acquisitions resulted in more prominence for geography, such as in national marketing planning and competitive siting of hospitals and clinics. On the y-axis of extent customer-facing, there were substantial changes in some industries due to fast, web-based delivery of enhanced map products in real-time. An example is real estate, where increasingly multimedia and map enhancements occurred. This is typified by a product such as Realtor.Com, which is very customer-facing with real-time nationwide maps and multimedia. An industry not present in 1995 but strong today is consumer portals with products such as Google Map and Earth, Microsoft MSN, Yahoo Maps, and Amazon A9, that deliver detailed maps on a worldwide basis. At the low end of customer-facing, some industries remain from 1995 such as metals manufacturing and pest management, for which consumers are not demanding interactive spatial interfaces and the firms are not providing them. Some industries such as transportation have become more customer-facing in certain functions such as automated vehicle navigation (AVN) and marketing, but remain internally focused in design, manufacturing, and other areas.

In the z-axis dimension of extent spatially-enabled web integration platform, industries such as consumer portals, media, and real estate lead the way, with continual, powerful, and appealing delivery of maps and spatial analysis to customers. Industries that have mostly not adopted the web- based platforms include banks, steel, and pest management. These industries have not seen sufficient benefits in spatial applications to justify the high costs of upgrading from desktop/client-server to web-based enterprise platforms.

This evolutionary framework can be expected to change further, since spatial technologies are currently in a phase of rapid advancement in business, due to reduced costs and more realization of the competitive importance of the benefits (Sonnen and Morris 2005, Francica 2005). The framework can be useful to managers who conduct mid- to long-range planning of their spatial architecture and applications. This paper now turns to eighteen case studies of businesses that use spatial technologies. Based on case analysis, each firm will be placed on the 2005 evolutionary framework, and the extent each business has identified spatial applications as strategic will be compared to the three factors of the framework.

3.1 Summary of Findings

The detailed findings for each case study firm cannot be included in this paper, due to space limitations. The summaries of the individual cases are available by request from the author. This findings section contains a summary to the results as they pertain to the research question. The case study firms vary on the three dimensions of the evolutionary framework, as shown in Figure 3. Size of firm has no consistent association with position in the framework, which implies that barriers to entry are low for spatial technologies in business. The extent applications are customer-facing relates to type of industry. Consumer services, billboard advertising, newspapers, and retail are industries that serve large numbers of customers. By contrast, the oil and utilities industries are more proprietary about retaining geographic information. Furthermore, post 9-11, those industries have been restricted by government policy from making publicly available certain types of spatial information, such as detailed maps of their network configurations and loads. The giant Credit Bank is in the early process of shifting from centralized service of customers with credit needs that are not spatially-based to serving emerging retail customers who often need spatial displays, but the bank's traditional habits are not spatially-oriented. The pest industry has not yet offered spatial displays to its customers, who don't seem ready to use it.

Regarding the extent of geography in businesses, it is keyed closely to industry characteristics. Those with the largest geographical component come from oil and gas, utilities, GIS consulting, and consumer services, while geography is less important for banking and newspapers.

3.2 The Research Question

The research question can be answered based on the case study results, which are summarized in Table 2. Detailed description of each case appears in Pick (2006). It is evident that strategic level is not related to extent of customer facing. In comparing the extent the eighteen firms are spatially strategic to the adoption of spatially-enabled enterprise-wide web integration platforms, they are highly associated for this sample. Five of the six firms that adopted web-based, enterprise-wide platforms have high to very high strategic levels for spatial technologies, whereas six firms in the traditional client-server mode have predominantly low (five out of six) strategic levels for their spatial technologies. The six firms in the middle level of spatially-enabled enterprise-wide web integration platform have medium to high strategic levels (4 medium, 2 high) for spatial. The Research Question is supported for the positive association of strategic level and spatially-enabled, enterprise-wide web integration platform.

4. DISCUSSION AND CONCLUSION

Spatial technologies have expanded rapidly in the business world. Uses are evolving, supported by spatially-enabled, enterprise-wide web integration platform. Sometimes location-based-service capabilities are added. As costs lowered, more

Table 2. Case study sample – Company Name/Description, Industry, and Size (strategic level refers to strategic level of spatial technology in the business. Note: the colors in the last two columns refer to spatial strategic level, blue=high or very high,, white=medium, and yellow=low)*

Name or description	*Size*	*Customer-Facing*	*Platform*	*Strategic Level**
Global Integrated Oil	large	Very low	Web-based, Enterprise-wide	very high
Kaiser Permanente	large	medium	Intermediate. Mostly traditional, client-server	medium
Large Credit Bank	large	very low	Traditional client-server	low
Large Commercial Bank	Large	low	Traditional client-server	low
Rand McNally	large	medium	Intermediate. Client-server, Enterprise-wide, moving to web	high
Southern Company	large	very low	Intermediate. Client-server, Enterprise-wide, moving to web	high
Sears Roebuck	large	medium	Intermediate. Client-server, Enterprise-wide, moving to web	high
URS	large	medium	Traditional, client-server	medium
Norwich Union	large	medium	Traditional, client-server	low
Lamar Advertising Co.	medium	high	Web-based, Enterprise-wide, moving to more functionality	high
Arizona Republic	medium	medium	Web-based, Enterprise-wide, limited to circulation and advertising	high
Western Exterminator	medium	low	Intermediate. Commercial web services	medium
Bay State Health	medium	low	Traditional client-server	low
Sperry Van Ness	medium	high	Web-based, Enterprise-wide	medium
Prudential Preferred Realty	medium	high	Web-based, Enterprise-wide	high
Engineering Systems	small	low	Traditional Client-sever	low
Motion-Based Technologies	small	very high	Web-based, Enterprise-wide	very high
MapGistics	small	low	Intermediate. Is partly web-based enterprise-wide	high

profitable uses were discovered. The present research proposes an evolutionary 3-dimensional framework for industry and firm applications of spatial technologies having three dimensions. The extent of customer-facing spatial applications has steadily expanded over time towards greater customer-facing. This is due both to the convenience and user-friendliness of the new technologies as well as to broader user bases. The extent geography is associated with the business has grown slowly, as the structure of industries altered or new industries emerged. An example is the web-portal industry sector, which emerged in the last eight to ten years and in 2005 took a giant step towards the general-public consumer with such offerings as Google Earth and Microsoft Virtual Earth. For established industries such as banking, the trend towards mergers and acquisitions can broaden the geography of the firm and make spatial applications more important.

Eighteen case studies were conducted of firms from different industries and size categories. Applications of spatial technologies are varied, but have advanced for all the firms as cost reductions and newer software and systems have made the technologies more beneficial and profitable.

The research question is supported by the positive association in 2005 of firm's spatial strategic level with spatially-enabled, enterprise-wide web integration platform. No association was evident between strategic level and customer-facing spatial application, nor between strategic level and extent of geography in the business.

The implications of the research are that a firm should evaluate its industry and determine how suitable it is to spatial technologies, as well as how much competitive advantage the technologies offer. Firms should consider deploying spatial applications on platforms that are web-enabled, as long as it can rationalize the investment from a cost-benefit standpoint. It should plan in the long term to evolve the applications to enterprise-wide. Some firms such as Motion-Based in this study have been able to leap-frog directly to full web-based enterprise spatial platforms and take the lead in market niches. Of course that increases risk and requires understanding of customer markets.

The research is exploratory. Future research can test the framework and the research question with a large sample survey that would statistically evaluate the preliminary findings reported here. This would lead to a more robust organizing framework. The research might be further strengthened by interviewing or surveying varied levels of employees in each firm, to assess each firm's responses from a variety of organizational perspectives.

Managers in businesses should consider what opportunities are present to improve productivity, lower costs, and strengthen strategic positioning through spatial technologies and GIS.

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