A SPATIAL INFORMATION SCIENCE APPROACH TO OPTIMIZING RECREATIONAL PLANNING FOR THE ACTIVITY OF DISC GOLF

By

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A RESEARCH PAPER

submitted to

THE GEOSCIENCES DEPARTMENT

in partial fulfillment of the
requirements for the
degree of

MASTER OF SCIENCE

GEOGRAPHY PROGRAM

March 2003

Directed by
Dr. P. L. Jackson

Acknowledgements

This project would not have been possible without the help of some key individuals. I would first like to thank Dr. Phil Jackson for allowing me to pursue this project and believing I could get it done. Secondly, I would like to thank the Professional Disc Golf Association for maintaining the most comprehensive source of disc golf information currently available and allowing me access to their data.

I would also like to thank Bill Anderson for introducing me to the game of disc golf and purchasing me my first disc. Andrew Hackethorn for allowing me to bounce ideas off of him and work through ways of developing this project. My roommates, Chris Russo and Cory Langhoff, for all the good times we've had living at the Farm. Finally, I want to thank my girlfriend, Gretchen Williams, for encouraging me to get my work done and listening to my complaints and my mom, Rebecca Miles, for all her years of support.

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A SPATIAL INFORMATION SCIENCE APPROACH TO OPTIMIZING RECREATIONAL PLANNING FOR THE ACTIVITY OF DISC GOLF

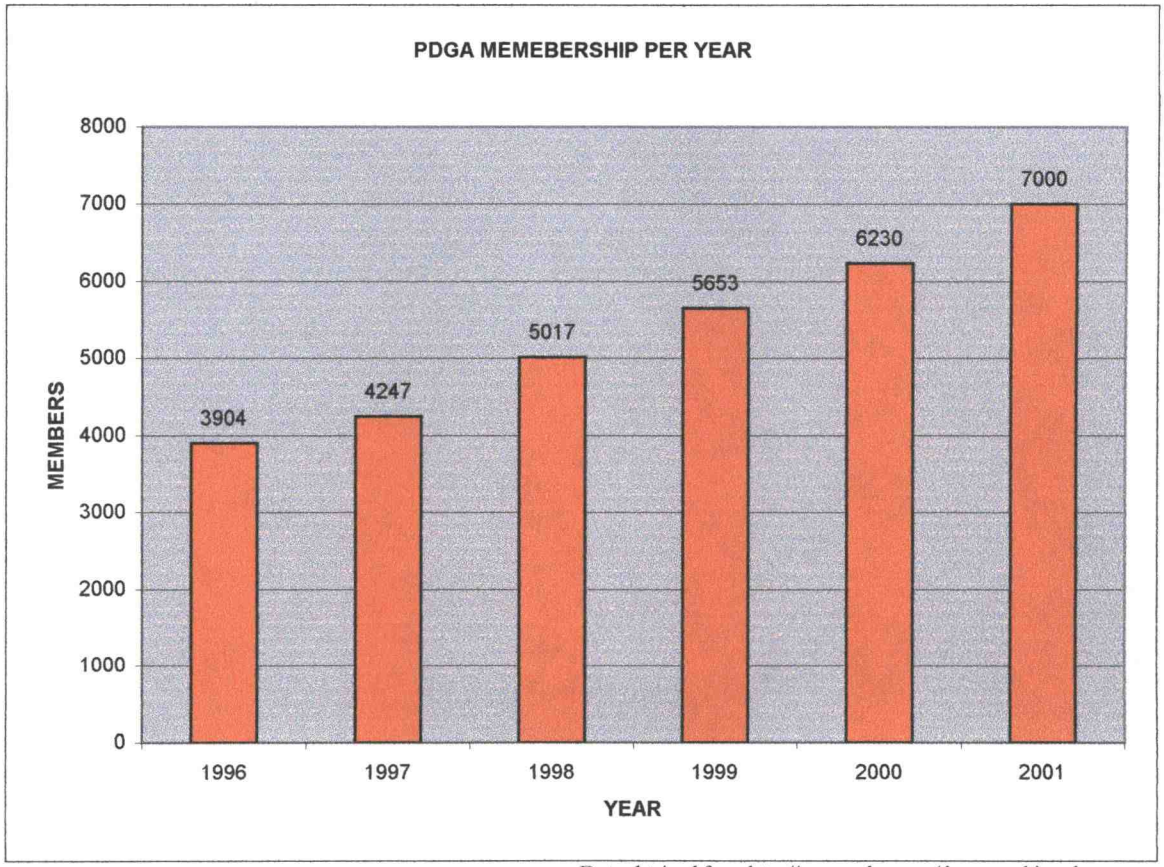
Abstract: GIS and other geographic mapping tools have become an integral part of our society for disseminating spatial information to assist in making informed land planning decisions. Disc golf is a recreation activity, most commonly found on public lands, which utilizes the natural landscape in a manner that enhances its enjoyment. By combining GIS capabilities and spatial data with the information available for disc golf it is possible to optimize the landscape design and location of future disc golf recreation sites.

Introduction

This research paper broadly addresses the topic of recreation geography and applies the science of Geographic Information Systems (GIS) to the formulation of a specialized approach to designing and optimizing the location of disc golf (DG) courses. The intended purpose of this research is to integrate GIS and other geographic tools (i.e. Geographic Positioning Systems (GPS), topographic maps, and pre-existing spatially referenced data) into the generally unexplored realm of DG. Graph 1 shows the number of players that have joined the Professional Disc Golf Association (PDGA) between the years of 1996 and 2001. Graph 2 depicts the steady increase in number of PDGA recognized courses that have occurred since 1975. Both of these variables are an indicator of the increased demand and popularity that DG has received from the recreating public. It is believed that GIS can help facilitate this recreational growth trend by spatially representing DG related information and data to create a Disc Golf Information System (DGIS).

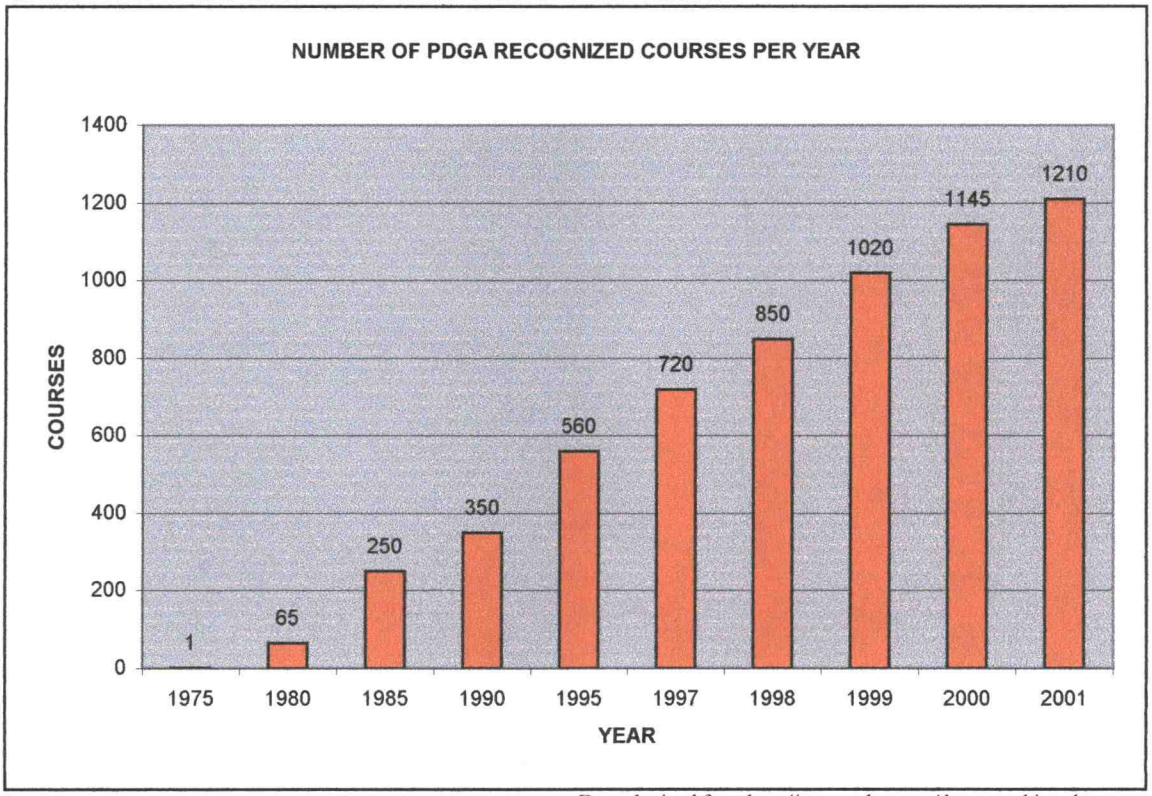
The following paper will address the steps taken and issues encountered to develop the DGIS. In addition, examples of the utility that the DGIS can offer to the DG community, the public and the public land managers where courses are generally located will also be provided. The format of the paper will following as thus: first, a brief history and introduction to DG; second, a discussion of the methods and sources used to create the DGIS; third, how DGIS can be applied and some analytical results that can be produced; and finally, a closing discussion of how the DGIS can be improved.

GRAPH 1: DISC GOLF PARTICIPATION



Data obtained from http://www.pdga.com/demographics.php

GRAPH 2: DISC GOLF COURSE DEVELOPMENT



Data obtained from http://www.pdga.com/demographics.php

The History of Disc Golf

As the late Ed Headrick theorized, the general activity of DG is one that may have been around since the dawn of man. Early hunters would have likely opted to kill an animal by throwing an object from a safe distance, rather than up close with a stick or spear. The least amount of throws needed to kill an animal would have been a desired goal, so practice and refinement of the projectile hunting technique and instrument would have naturally progressed (Disc Golf Association, An Abbreviated History, www.discgolfassoc.com/history.html). However, DG as a pursued recreational activity did not form until the mid-1970s and the inventions of aforementioned "Steady" Ed Headrick.

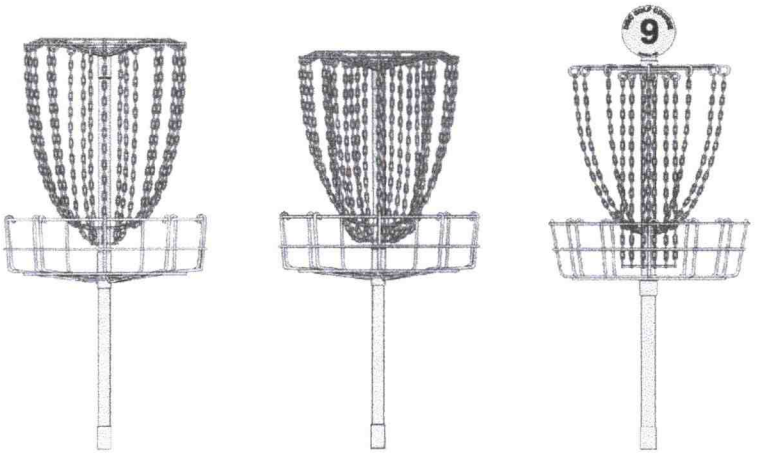
The history of DG's development roughly progressed as such. Late 1950s Wham-O Corporation obtains a patent on the Frisbee® flying disc, which had been originally designed and popularized at Dartmouth College earlier that decade. Circa 1964, Ed Headrick is commissioned by the Wham-O Corporation to design a product out of the excess Hula Hoops that the company was stuck with. Headrick designs the 108 gram "Official Pro Model" Frisbee® for flying disc sports (Disc Golf Association, 33Years With The Frisbee, www.discgolfassoc.com/history.html). Between 1964 and 1975, primitive forms of DG began to emerge across the country. The courses became known as "Object Courses," where anything from lamp poles and fire hydrants could be constituted as a target (Palmeri & Lambert, www.treelove.net/history.htm). "Frisbee Clubs," such as the International Frisbee Association (formed by Headrick), and large event disc competitions, such as the World's Frisbee Championships held at the Rose Bowl in Pasadena, California, began to emerge.

In 1975, the first permanent DG course was established at La Canada, California's Oak Grove Park. A year later, 1976, Headrick invents the MACH Series Pole Hole®, a chain-style DG basket (Figure 1). That same year he also forms the Professional Disc Golf Association (PDGA). The following year—1977—the PDGA hold its first tournament initiating the modern era of DG competition (Palmeri & Lambert, www.treelove.net/history.htm). In 1982, Headrick relinquishes control of the PDGA to be a player run organization. By 1980 and on into the modern era, permanent and recognized courses have been established around the world. Table 1 shows the number of PDGA recognized courses for countries where courses have been developed. DG champions have emerged as role models for the sport, along with sponsorships, promotions, and

specially designed discs. This rather short history for DG is offset by its continuous gain in popularity and notoriety among a wide range of individual ages, skills, and demographics as represented by PGDA membership in Table 2.

FIGURE 1: QUIENTISSENTIAL DISC GOLF COURSE EQUIPMENT

The illustrations below depict the three most popular standard styles of DGA Pole Holes



Mach "New" 2 Mach 5 Mach 3

http://www.discman.com/faq/polehole.html

TABLE 1: NUMBER OF PDGA RECOGNIZED DISC GOLF COURSES BY COUNTRY IN 1998

Courses by Country:	
USA	1012
Sweden	58
Europe - other countries	48
Canada	35
Japan	35
Australia / New Zealand	20
Latin America	2
Total	1210

Obtained from http://www.pdga.com/demographics.php

The Activity of Disc Golf

In order to appreciate the recreational opportunity that DG provides it is important to first understand what that recreation is. DG is similar to its highly promoted older

cousin, 'ball' golf (BG) in that the goal is to get an object from a designated starting point to a designated target in the least amount of throws (strokes) possible to obtain a low score. Where the goal for BG is to get the ball from a tee into a cup in the ground, the goal for DG is to get the disc from a tee to a course-designated target. A course-designated target can range from a well-marked tree to the most definitive of DG apparatus, the "basket" (Figure 1). Furthermore, much as the BG player uses different length and weight clubs to drive the ball a desired distance and direction to achieve the low score, the DG player also has an array of different sized and shaped disks to accomplish a similar result.

TABLE 2: PDGA 1998 MEMBERSHIP DEMOGRAPHICS

Age:	
Under 12	1%
13-20	2%
21-30	20%
31-40	52%
41-50	22%
Over 50	3%
Household Income (US$):	
0-10000	2%
10-20 000	7%
20-30 000	17%
30-40 000	15%
40-50 000	15%
50-100 000	36%
> $100 000	8%
Education:	
Grade school	1%
High school	20%
Some college	24%
College graduate	42%
Masters	9%
Advanced degree	4%

Obtained from http://www.pdga.com/demographics.php

Both activities use tee pads as their starting position; however, DG tee pads are different in that they can be either non-impervious natural surfaces (i.e. dirt) or hard impervious surfaces (i.e. concrete). Tee pads for new DG courses are typically natural surfaces, however, over time these non-impervious surfaces often present environmental degradation problems, player safety and increased managerial concerns. Hard surface tee pads, which are the PDGA's suggested standard, can eliminate the degradation caused by the continual use of non-impervious tee pads. This reduces the maintenance and management that is required by a DG course.

The recommended size of the hard surface tee pad is 6 ft wide by 12 feet long and 4 inches thick, which is approximately 1 cubic yard of concrete (New Course Proposal Template, www.disclife.com/prop.shtml, 4-11-99). However, the length of tee pad can be increased or decreased according to the layout of the hole. For example, a shorter 8 or 10-foot long tee pad can be used on short or downhill holes because not as much distance is required from the throw, hence less room is necessary to gain the distance.

The most essential feature of a DG course is the target, which can range from any well-marked object, such as a tree or post, to the most permanent and definitive DG course apparatus, the "basket" (Figure 1). The choice as to which target will be used on the DG course is a matter of budget, design goals, and overall player usage of the course. Most new courses will either use the natural features located throughout the landscape or some inexpensive easily removable structure. Once the need and demand for the course can be determined, decisions for more permanent targets can be made.

The basket, which stand approximately 41/2 to 5 feet tall, are positioned in the ground via an anchor assembly sleeve that is set into a concrete filled hole measuring

roughly 8 inches in diameter by 18-36 inches in depth (New Course Proposal Template, www.disclife.com/prop.shtml, 4-11-99). This method allows multiple anchor assembly sleeves to be mounted into the ground, and the basket itself can be repositioned or removed if needed. This not only provides a variety of playing alternatives for a course, but it also helps to reduce environmental impacts by redirecting player traffic or allowing the managing agency to close the course if needed (no targets = no game).

The tee pads and targets are generally the only two structures that distinguish a DG course. However, signs that display the distance and the layout of the hole can be positioned next to each tee pad. Other structures, such as parking space and kiosks, should also be included into the course design to provide access and information. Often, however, these structures are already established as part of the existing public recreation site, and therefore, do not need to be added to accommodate the instillation of a DG course.

Beyond these few commonalities, the similarities between DG and BG quickly fade and the dissimilarities increase. The first and most obvious difference is the alteration (or lack there of) of the landscape. DG courses have the distinct characteristic of utilizing the natural landscape to provide the obstacles, hazards, and boundaries that challenge the player (Disc Golf, the PDGA, and the Environment, pdga.com/environment_doc.phtml, 7-16-02). Part of the overall experience and "fundamental pleasure" of playing is the notion that the game is played in a natural setting. For comparison, BG courses require the removal of large amounts of vegetation, the fill and dredge of wetlands and lowlands, the re-contouring of the terrain, the diversion and regulation of water patterns, and the re-vegetation of non-native grasses

and flora that require the continual application of fertilizers and chemicals. In addition, numerous impervious surfaces, such as cart paths, roads, parking lots, clubhouses, refreshment stands and residential developments are also incorporated into the design. The sacrifice of the natural landscape to the permanent and virtually irreversible alterations required for a BG course has consequences to the flora, fauna, and water quality well beyond the boundaries of the course itself. However, due to the nature in which DG is played it is not with completely without its environmental impact.

As a result a few standards have been established to minimize the environmental consequences and multiple use conflicts that can arise by changing the land usage of public spaces. Though these standards are mere suggestions and do not require complete compliance, they have been able to fulfill certain identified goals. These goals include:

A. Satisfying the design requirements of the people and organizations who approve use of the land and fund the equipment for the course.
B. Designing the course to be safe for both players and non-players who may pass near or through the course
C. Designing the course with potential for multiple configurations to serve not only beginners but players with advanced skills; consistent with the budget and design needs expressed in Goal A above.
D. Designing a well-balanced course with a wide range of hole lengths and a good mixture of holes requiring controlled left, right, and straight throws.
E. Utilize elevation changes and available foliage as well as possible. Take care to minimize potential damage to foliage and reduce the chances for erosion.

(PDGA, Disc Golf Course Design Standards, 2000)

The first suggested design standard is that a "Community Full Service" course (one that accommodates all skill levels) has at least 1 acre per hole, while Recreational Standard courses (one that is not designed for tournaments) can accommodate 2-3 holes per acre. Additionally, it is suggested that total course lengths for 18-holes range from 3600-4300 feet for the shortest course layout, which accommodates beginners and novices, to 4500-6000 feet for the longest course layout, which accommodates more

advanced players. Courses that offer lengths beyond 6000 feet are typically designed for expert and tournament play (Disc Golf Course Design Standards, pdga.com/makecrse.phtml, 4-24-00). A single course, however, can meet all of these player specifications by offering alternative hole lengths through multiple tee pad and target configurations. The designation of which type of course to implement onto a recreational land depends on the desires expressed in Goal A and the amount of available land.

There is no requirement as to the number of holes that must be designed into a course. However, the normal standard is 9, 18 or some number that is divisible by 3. The general rule is that it is better to design a fully functional, safe and enjoyable +/- 12-hole course than it is to design a cramped, dangerous, and unpleasant 18-hole course (Disc Golf Course Design Standards, pdga.com/makecrse.phtml, 4-24-00).

It should be noted that even with the minimal infrastructure necessary for a DG course to function, it is not without its environmental problems (Disc Golf, the PDGA, and the Environment, pdga.com/environment_doc.phtml, 7-16-02). As with any development project changing land uses can result in impacts to the natural landscape and the larger ecosystem. Due to the increasing growth in DG participation, public lands with courses are seeing increased environmental degradation, because players often travel into areas that would otherwise not receive visitation (i.e. the middle of a black berry patch). This results in native and sensitive vegetation being trampled and destroyed. Another environmental consequence is the rutting of pathways between the tee pads and targets. This can alter drainage patterns and increase erosion, which can amplify sediment loads into nearby streams or drainage systems. Impacts such as these can often be mitigated

well before they become serious environmental and managerial problems. With comprehensive course design strategies (i.e. well-marked and conveniently located foot paths to direct the flow of foot traffic), course layout alternatives (i.e. alternative basket placements to direct game play away from areas needing protection), thorough management strategies (i.e. establishment of environmental damage thresholds), and strong support from a local DG organizations (i.e. to provide education, watchful eyes, and continuous maintenance labor), managing and maintaining the environmental consequences of a course can be addressed before the problems arise.

One final characteristic of DG is the initial cost required for an interested recreationist to participate. Where BG requires an enormous financial commitment for even the most seldom of players, DG can be enjoyed the first time with nearly no financial investment required. BG's initial start-up cost includes purchasing clubs, bags, balls and tees, which can cost into the hundreds of dollars. On the other hand, the only equipment a DG player needs is a disc that costs anywhere from $8 - $12. Furthermore, most BG courses require the payment of a fee in order for the player to be permitted to play, where as DG courses are normally located on public land and participation is generally free. However, this may be changing due to the increased management needed to maintain the effects of growing participation. For these reasons, when considering recreational opportunities for the general public a DG course can satisfy a wider demographic recreational cross-section than a BG course.

Disc Golf and GIS: The Making of the Disc Golf Information System (DGIS)

This project was initiated as an attempt to develop a method for identifying public lands that are suitable for a DG course, while also addressing the needs of the general

public and the DG community. The belief was that identifiable and measurable course standards and criteria had been developed and that these standards could be incorporated into a GIS for the purpose optimizing the location of DG courses. However, upon investigating the current nature of DG and GIS it was found that the two had yet to be intergraded. Chuck Kennedy, who heads the independent Course Designers Group, reports that he has used GPS technology to "determine where park boundaries were located in an area that hasn't been developed yet" and "to locate all of our tee and pin positions to help produce a more accurate map and to calculate elevation changes on each hole" (Kennedy, 10/23/01). However, he "know[s] of no situation where GPS info [spatial data] was used to determine whether a property might be suitable for a DG course" (Kennedy, 10/23/01). Due to this lack of available information and standards, it became necessary to reevaluate the direction and scope of this project.

It was decided that in order to incorporate DG and GIS together it would first be necessary to evaluate the current state of DG information. The PDGA offers the most comprehensive source of DG information available. Through the PDGA's website (pdga.com) information about how the game is played, official rules, membership information, tournament standings, course development guidelines, a course directory, and much more is available. Of particular interest to this project was the course directory, which contains such information as directions to the courses, a list of on site facilities, tee pad construction, target type, course length statistics, course development and modification date, course manager and/or course pro contact information, and any special instructions pertaining to a particular course. However, the PDGA does not officially collect this course information, instead it relies on the players and/or course managers to

submit the course information via an Internet submittal form (www.pdga.com/new_course_user_insert.php). Due to this relatively non-standardized method for collecting and classifying course data and the static non-spatial nature of this data format, relatively little analysis can currently be preformed. It was due to this lack of comprehensive, standardized geospatial course data that initiated the development of the DGIS.

The first step in the development of the DGIS was to define the area of study and to determine what spatial information sources were available. Since the PDGA lists 1142 courses nationally and 242 internationally (Disc Golf Course Directory, www.pdga.com/dgc-online.php, 1-23-03) it seemed necessary to narrow the project to a more manageable working area. The Pacific Northwest (Oregon, Washington and Idaho) was chosen as the study area due to the researchers geographic location and ability to access courses locally. Through email and telephone correspondences with Brian Hoeniger, PDGA Administrator, and Theo Pozzy, PDGA Regional Director, a digital spreadsheet of the PNW DG courses was obtained from the PDGA for specific use in this project. Table 3 list and describes the information provided by the PDGA for the PNW DG courses as it was received. Because this data is voluntarily submitted to the PDGA, through its website by people from the DG community, many of the data fields contained no information or the information provided was inconsistent within a field. However, this information not only provided the greatest amount of assistance in spatially locating the PNW DG courses but this spreadsheet also provided the framework for the initial data that the DGIS provides.

It also became necessary to find and format background information and base data to provide a reference for the spatial location of these courses. It was decided that the U.S. Census Bureau's T.I.G.E.R. files and ESRI's USA shapefiles would be used due to their ease of accessibility and use, and the relative thoroughness of their feature attributes. Of particular importance in these datasets were ESRI's PNW county and state shapefiles and the U.S. Census Bureau's PNW landmark, road and place shapefiles. This data was incorporated into the GIS in a geographic projection system (i.e. longitude and latitude). Where needed this data was joined in order to create a complete coverage for the PNW (Map 1).

In addition, three other ancillary sources of information were used as spatial reference material. The first includes the DeLORME Oregon, Washington, and Idaho Atlas and Gazetteer's, which were used to help identify and locate parks and features that did not exist at the level of detail available within the T.I.G.E.R. or ESRI data files. The second source was MapQuest (www.mapquest.com) and Yahoo Maps (http://maps.yahoo.com/), which are online sources for obtaining driving directions and maps for a specific location. These were used to obtain street and road information to more accurately locate some courses. The third source, where applicable, was locally maintained websites that promote DG courses within an area. Therefore this source also represents the best source for updated information concerning a course. This source not only provided information as to where the course was located but, in some cases, also provided information as to how the course was designed by having course maps available online.

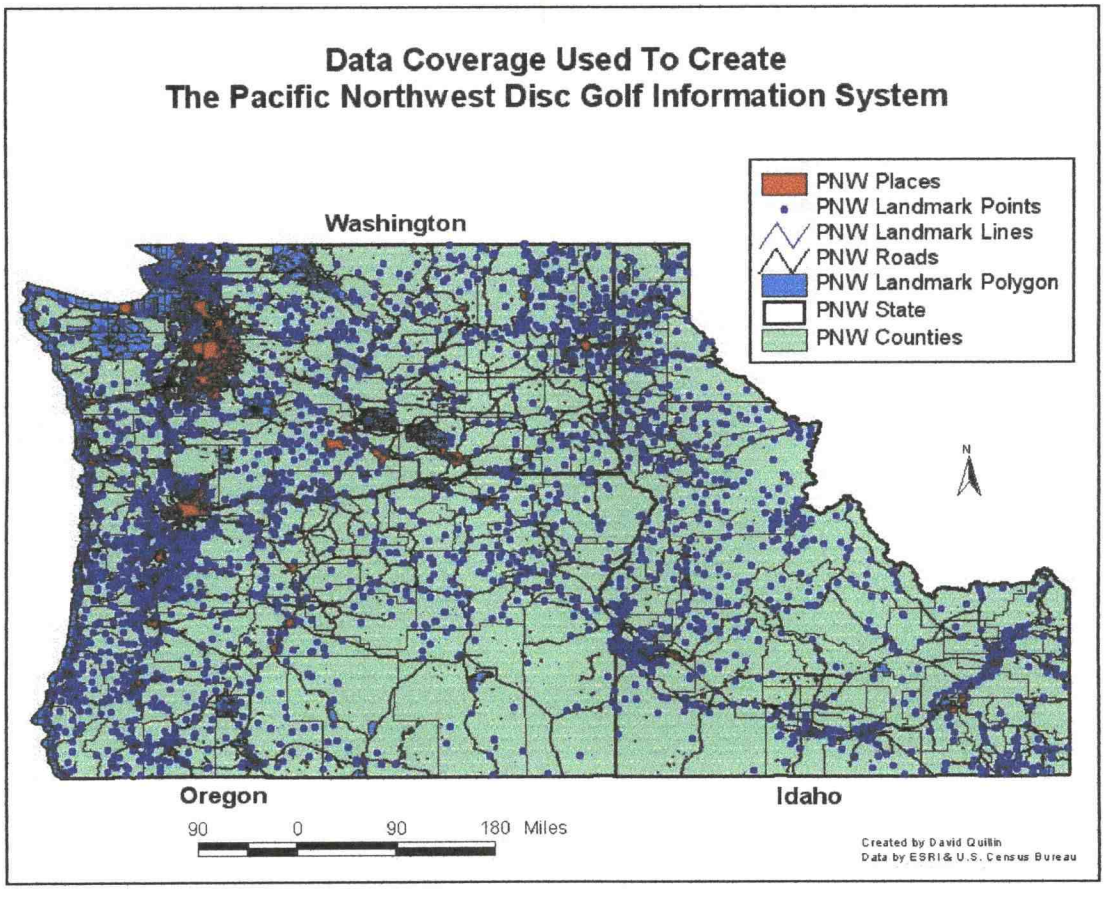
The next step was to determine how best to spatially locate the DG courses on the landscape and record this spatial information in latitude and longitude coordinates. The easiest and most accurate method for this is to use a Global Positioning System (GPS) receiver to obtain the geographic coordinates. Using a GPS receiver, coordinates can be

TABLE 3: PDGA PROVIDED PACIFIC NORTHWWEST COURSE DATA

PDGA Course Data Spreadsheet Headings	Description
Courseid	PDGA Course Identification Number
Course	Name of course
City	City of course location
State	State of course location
Cntry	Country of course location
Directions	Driving directions to course
Holes	Number of holes and target type on course
Tees	Tee pad surface type
Feet	Total distance (feet) for course
Dist1	Number of holes less than 300 feet
Dist2	Number of holes between 300 and 400 feet
Dist3	Number of holes greater than 400 feet
Descript	Course description and information
Proname	Course pro / information contact
Propdga	Course pro pdga number (if applicable)
Proaddr	Course pro's address
Procity	City of course pro's location
Prozip	Zip code of course pro
Hphone	Home phone of course pro
Wphone	Work phone of course pro
Modified	Date course was last reported altered
Est	Year course was established
WWW	Course information on World Wide Web
Email	Email address of course pro
Altfeet	Course's alternative target distance (feet)
Facilities	On site bathroom availability
Camp	On site camping availability
Fee	On site payment system established
Hcap	On site handicap accessibility
Sign	On site hole description markers
Private	Course ownership
Zip	Course location zipcode

collected for the tee and pin positions on the course as well as the location of other features such as bathrooms, parking lots, etc. This method was used to locate and map the Adair Park Disc Golf Course (Map 2). However, GPS receivers require data to be collected while in the field and because of money and time constraints this method was determined to be inadequate for the scope of this project. (See Conclusion for a more in-depth discussion of the methods used to collect GPS data). Instead an alternative method was used to spatially identify the location of the DG courses.

MAP 1: BACKGROUND SOURCE DATA



The alternative method involved using the sources described above in various combinations in order to identify the location of the course within the park or area it is located. Since little spatial information exists for DG courses and direct visitation to each

course was impossible, it became necessary to compile multiple sources of information in order to spatially locate the courses. This involved first reviewing the PDGA course data in order to identify the state, county, city and park or private property where the course is located. Then within the T.I.G.E.R. and ESRI shapefiles the state, county, city and park/private property of each course were identified to the level of detail available. In most cases states, counties and cities were identifiable, however parks/private properties either did not exist within the shapefiles or were unidentifiable. In order to find the parks/private properties the Delorme Atlas and Gazetteer's and the Internet mapping tools (MapQuest and Yahoo Maps) were used to locate them. This required identifying similar features (i.e. roads, water features, places, etc.) among the different data sources in order to narrow down the correct location of the park/private property for the course. Finally, where applicable, course designated websites where used to more specifically identify where these courses might be were located within the park/private property.

Once a location for the course was identified through the various data sources, it was referenced with the T.I.G.E.R. and ESRI shapefiles. This would require placing a point in the GIS at the location identified as the course. Since these shapefiles are spatially corrected, the latitude and longitude coordinates of this point could be determined and recorded. These coordinates were then entered into the PDGA's course data spreadsheet for the appropriate course. This spread sheet was then converted into a shapefile so that the location of each course could be graphically depicted on the landscape. Appendix 1 shows the latitude and longitude coordinates that were used to locate each DG course, while Map 3 is the graphical representation of the DG courses on

the landscape. It should be noted that these points only represent an approximate location of the courses on the landscape generally and not the course's actual layout.

MAP 2: GPS COLLECTED COURSE LAYOUT

The general purpose of the DGIS is to make DG information as accessible and useable to the greatest audience available. In order to achieve this it was felt that some adjustments needed to be made to the categorization and classification of the PDGA's course data spreadsheet. In addition, some categories (i.e. pro information) were removed from the spreadsheet due to their lack of relevance to course specific information. These adjustments were done for the purposes of making the DG course information more understandable. Table 4 shows the new categories and classes after adjustments were made to the PDGA course spreadsheet. However, having addressed how this course data

was originally collected, it should be evident that the errors that exist in this data can only be attributed to the source of the material due to the lack of any accuracy assessment standards.

In addition, other sources of error also exist within the DGIS. When compiling multiple sources of information for the purposes of representing a new concept for which the data was not originally intend many sources of error can be introduced. These errors can propagate because of the inaccuracies that exist between the different data sources. Spatial inconsistencies exist between the T.I.G.E.R. files and the ESRI data because they were both created at different scales using different digitizing methods. As a result the

MAP 3: PACIFIC NORTHWEST DISC GOLF COURSES

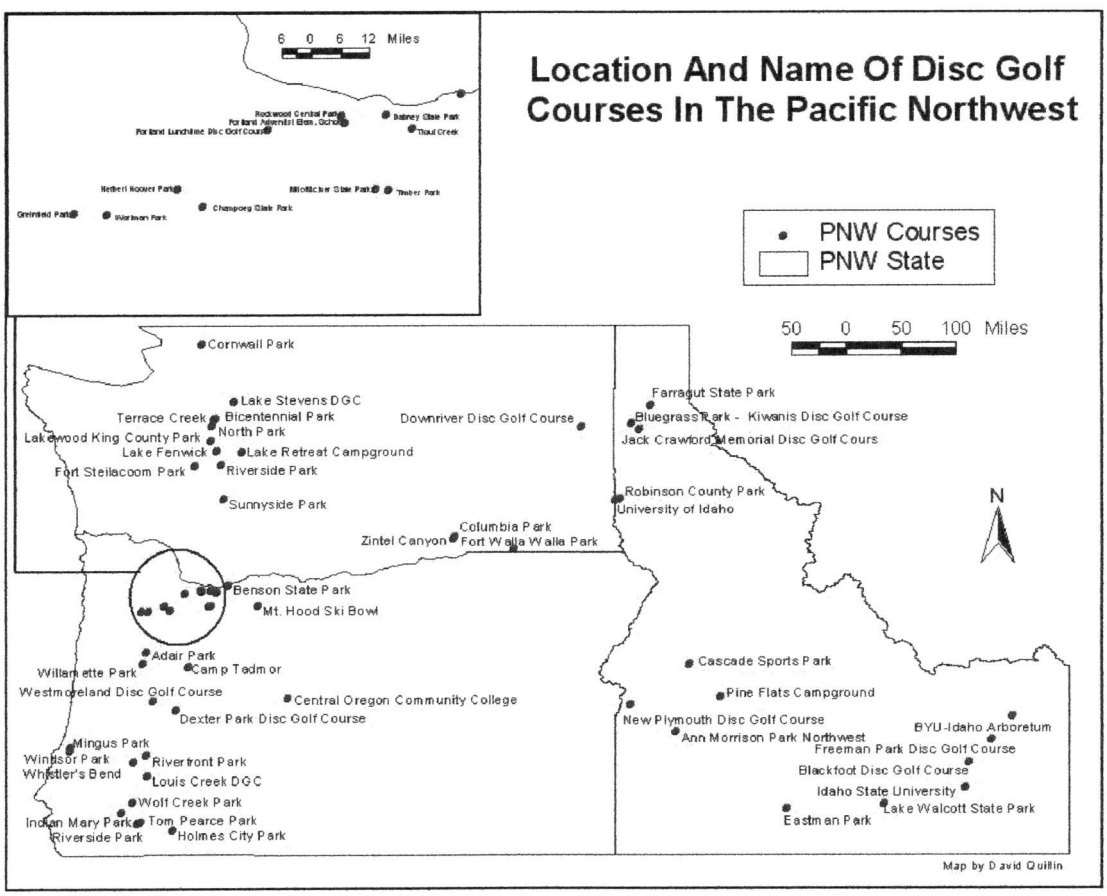


TABLE 4: DISC GOLF INFORMATION SYSTEM COURSE ATTRIBUTES

DGIS Course Information Headings	Description
Shape	ArcInfo shape property
Courseid	PDGA Course Identification Number
City	City of course location
State	State of course location
Cntry	Country of course location
Latitude	Latitude of course location
Longitude	Longitude of course location
Directions	Driving direction to course
Holes	Number of holes and target type on course
Pin_#	Number of pins on course
Pin_type	Type of target on course
Tee_type	Type of tee construction material
Feet	Total distance (feet) for course
Holes<300ft	Number holes less than 300 feet
Holes300-400ft	Number holes between 300 and 400 feet
Holes>400ft	Number of holes greater than 400 feet
Descript	Course description and information
Est	Year course was established
Altfeet	Course's alternative target distance (feet)
Modified	Date course was last reported altered
Facilities	On site bathroom availability
Camp	On site camping availability
Fee	On site payment system established
Hcap	On site handicap accessibility
Sign	On site hole description markers
Private	Course ownership
Zip	Course location zipcode

spatial accuracy of the DGIS is compromised by the scale and level of detail at which the base data was created. For example, some reference information, such as parks, roads and towns that was needed to accurately locate a course did not exist within the base data. Due to this discrepancy in the original data, general assumptions and adjustments needed to be made in order to best identify the most accurate course location possible. As a result the coordinates used to represent the DG course on the landscape may not be the actual location of the course at all. However, it was assumed that for the initial purposes of this

project that these spatial errors would be acceptable for the DGIS. Later this paper will address ways to improve the spatial accuracy of DGIS in the future.

The Disc Golf Information System Capabilities and Analysis

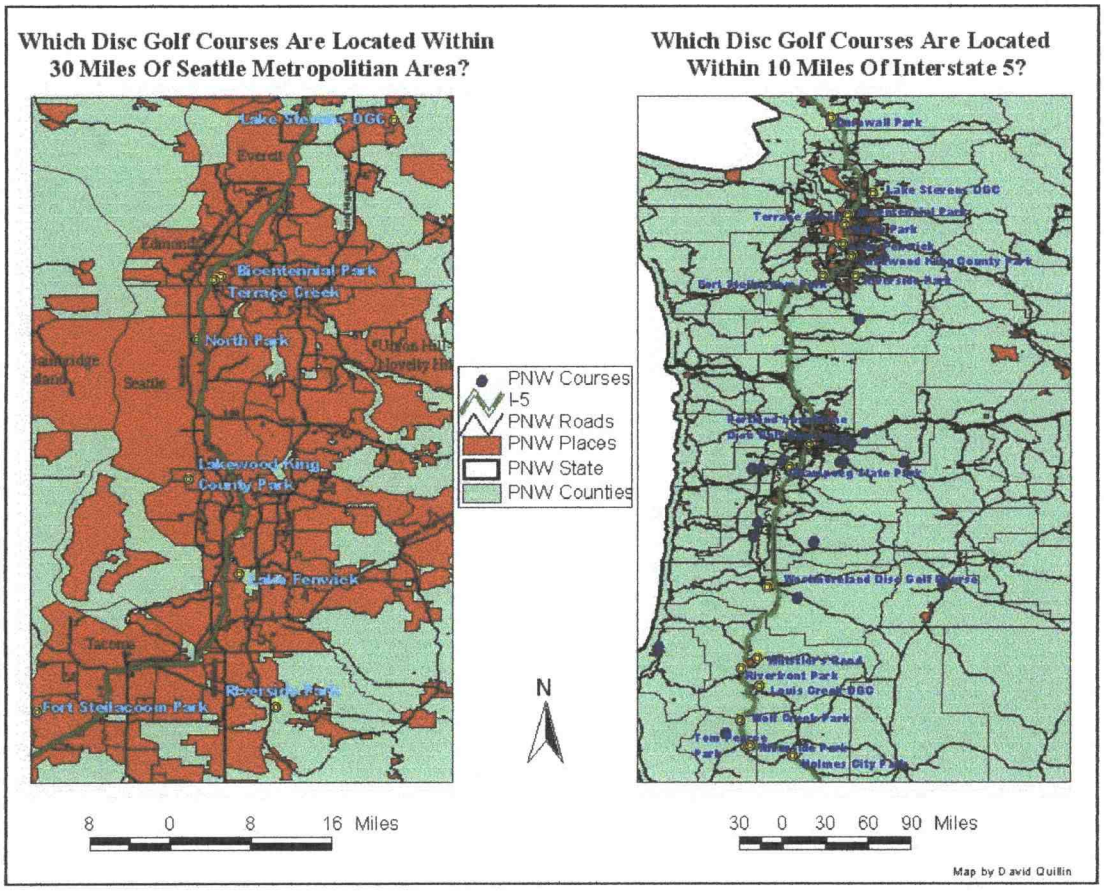
Even with the errors identified above, the DGIS is still capable of performing some basic analysis functions. Through basic GIS querying capabilities some preliminary results about the location and attribute characteristics of the PNW DG courses can be revealed. It is impossible to gage the enormous potential by which a DGIS could be used because the needs of the public are too large to interpret. However, for the purpose of this project three different personality types, which are believed would use the DGIS, have been conceived. The three personalities are: the General Player, the Manager, and the Tournament Organizer. Though these three personalities are not mutually exclusive, they do offer three unique perspectives as to how the DGIS could be used and how it can be further designed and implemented. The following section will address how these three personalities would each individually approach and use the DGIS.

The General Player

The General Player—player—represents those DG recreationists who are interested beginners, seasoned veterans and professionals of the game. There are several good reasons why a player would want to access a DGIS. For example, beginners may want to learn about the game; where local courses are located; and what clubs, organizations or contacts are available to help support their game development. Information such as this may be accessed through the DGIS. In addition, seasoned players can use the DGIS to find courses that challenge their playing ability or match

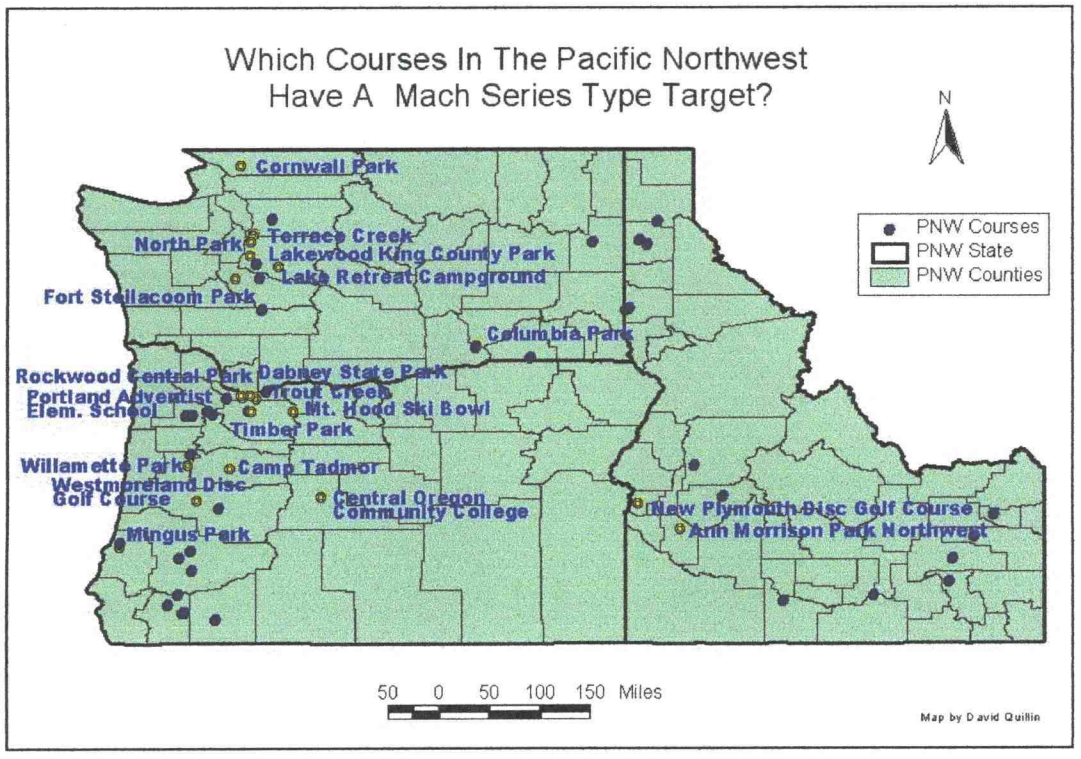
their playing ability with others. In this capacity, the DGIS would act as a general information resource tool from which players can obtain DG related information.

MAP 4: GENERAL PLAYER QUERY 1 & 2



In its current state the DGIS is capable of being queried to answer locational questions. By uniquely identifying courses by location the player can find which courses meet the distance they are willing to travel to a course and which courses within that distance meet a specific criteria (i.e. basket type). The questions a player may ask could look as such: Which courses are located within 30 miles of Seattle metropolitan area? Which courses are located within 10 miles of Interstate 5? Or, which courses in the PNW have a Mach series type target? Maps 4 and 5 illustrate the results of these questions and provide an example of the utility that the DGIS could provide the player.

MAP 5: GENERAL PLAYER QUERY 3



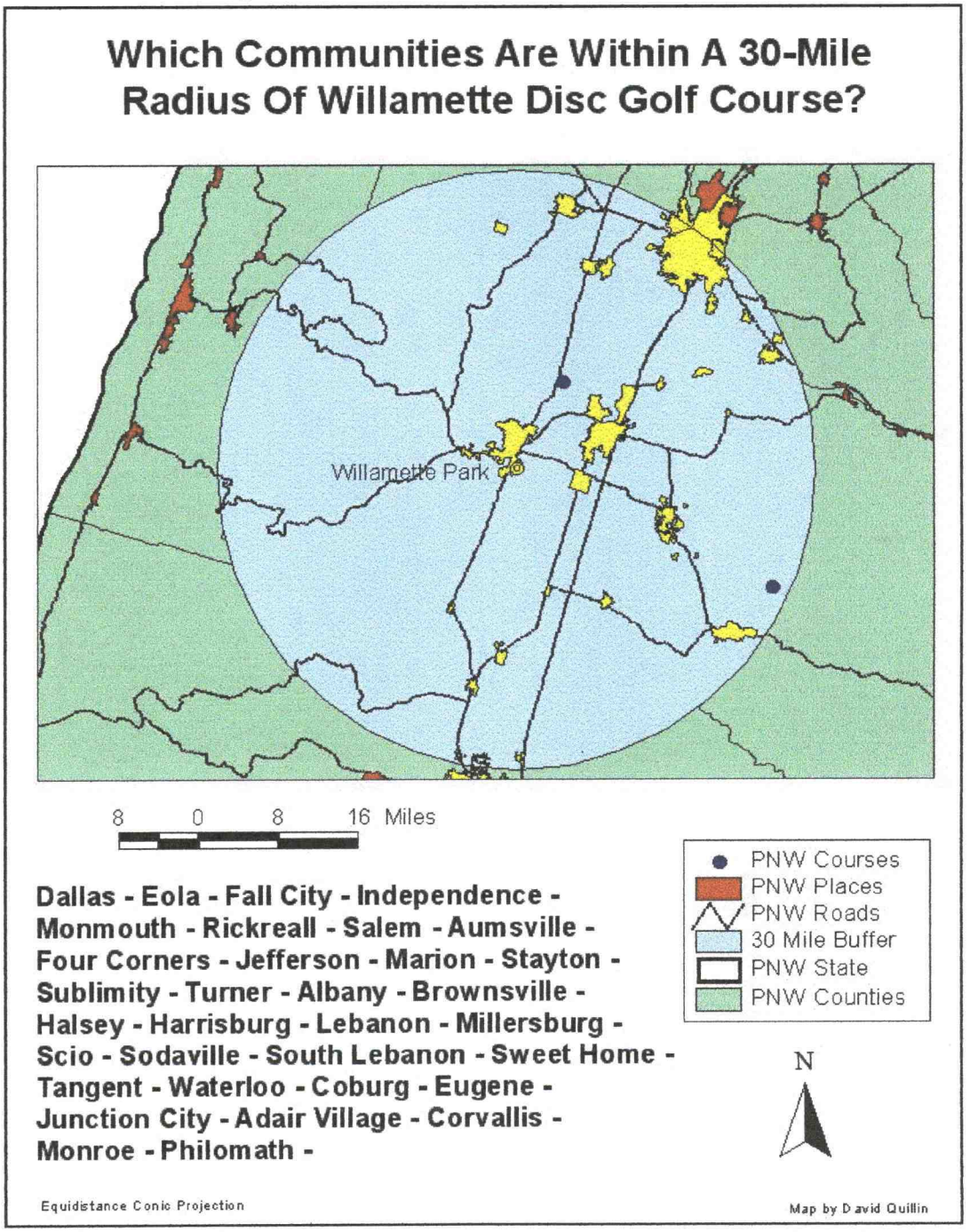
By having a comprehensive system available to the player, it is believed courses that are generally unrecognized would experience increased usage. When the player is able to answer locational questions, they are likely to find the courses available to them that they were previously unaware of. Furthermore, with this course information players may be able to customize a playing level that is suitable to their playing ability. However, in order for this to be achieved cooperation and consistency among the DG community and clubs need to be established and maintained. This would help insure that course information would be up to date and accurate should new courses be developed or a course design is altered. Furthermore, a course rating system, such as the one developed by Fred Chittenden (Appendix 2) would need to be implemented in order for the players to be better able to assess their playing needs.

The Manager

The Manager represents those whose interests lie in the allocation of land for courses, the design of the course and the continual management and improvement of the course. The Manager's interests are different from the General Player in that the Manager's concern lies in the identification and use of public lands for the purpose of designing and developing a DG course. This category may include city, county, and state park officials and members of the public who wish to voice an opinion on public land issues. The DGIS can be queried to answer spatial questions to help determine the accessibility and potential demand on current courses. In this capacity, the DGIS becomes a tool to help rationalize a case for promoting or opposing the development of a course. For example, by asking which communities are within a 30-mile radius of Willamette DG course (Map 6) or how many communities are currently not being served by a course within 30-miles (Map 7), a course planner could determine which communities may benefit by having a course within closer proximity. Furthermore, by asking how many courses are within 20 miles of Seattle (Map 4), a legitimate argument may be presented for not having a new course developed within that area.

On the other hand, the objectives of the Manager and the General Player are similar in that in order to understand what makes a DG course challenging, fun, and functional the Manager must have a Player's perspective of the game. Since the landscape (both natural and human) is the dominant determinant of the layout and design for a course, it is necessary to understand not only the fundamental principles of DG (i.e. flight patterns and throwing styles) but also the various needs and abilities of the Players. The Manager is not only concerned with getting a course implemented but also locating

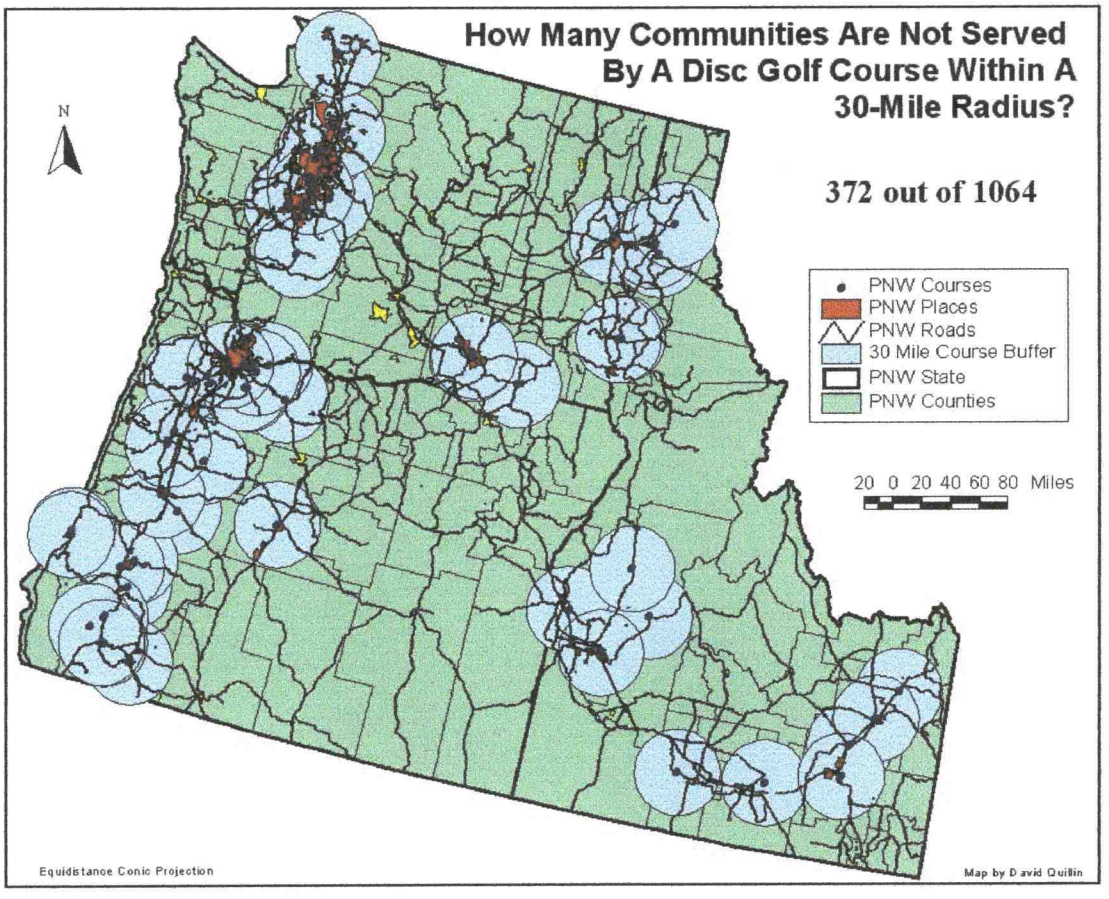
MAP 6: MANAGER QUERY 1



and designing the course in a manner that promotes its continuous use. In this capacity, the Manager could query the DGIS to determine what kinds of courses are serving a community within a certain distance. For example, by asking how many courses within

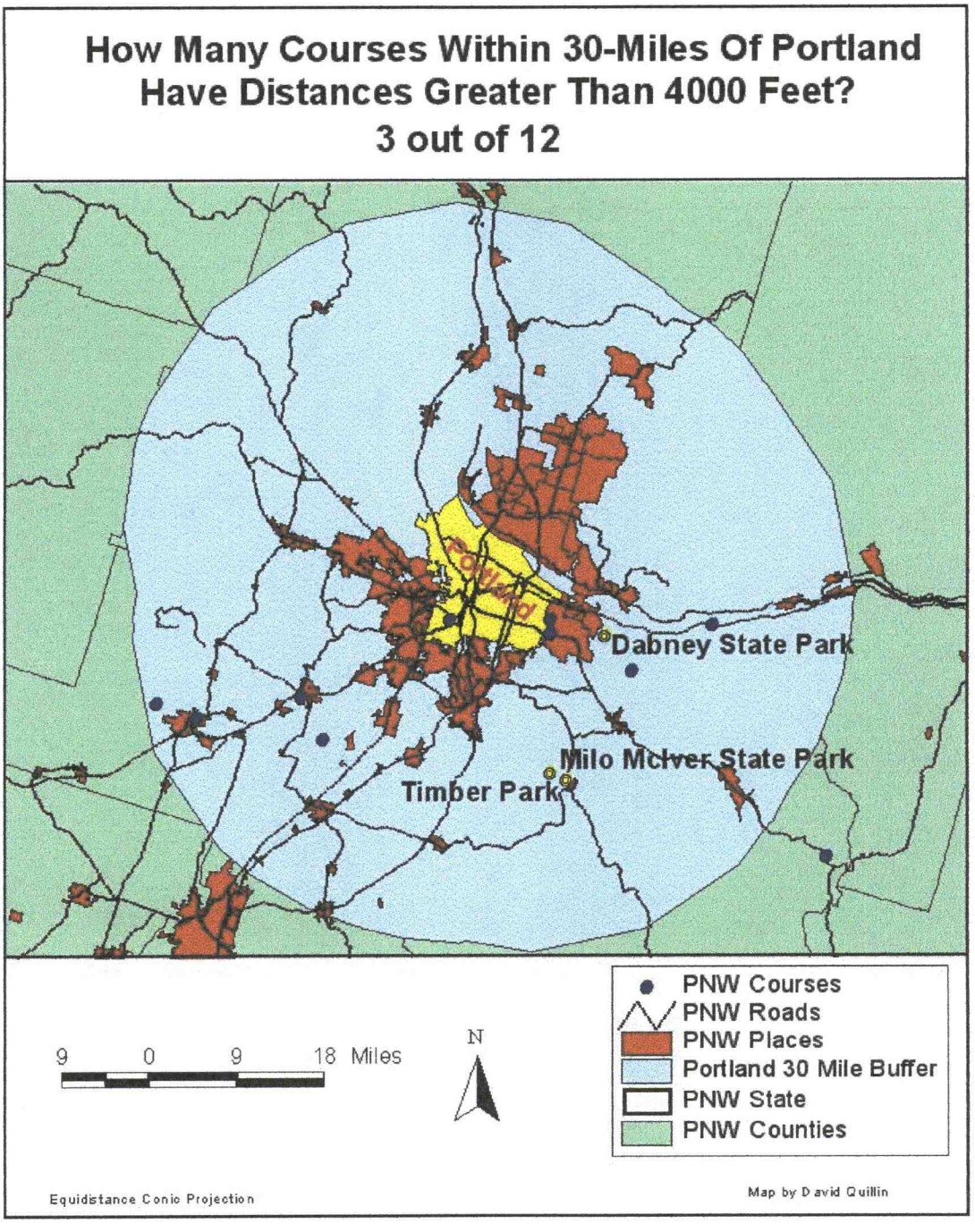
30 miles of Portland have total distances greater than 4000ft (Map 8) could show the Manager what kind of future course development should occur in that area.

MAP 7: MANAGER QUERY 2



Combined the Manager encompasses an enormous role in the continuing popularity of DG both on the side of the Player and the side of the general public. Decisions involving public land use allocation are politically and socially fueled by what is thought to be the best use for that land. To legitimately present an argument for or against the implementation of a DG course on public land, accurate and through facts must be presented in a manner that effectively addresses the issue at hand. The DGIS is designed to show the current condition of DG. In this capacity questions involving how DG currently utilizes the land are solved, therefore possibly justifying land use decisions

MAP 8: MANAGER QUERY 3



for course allocation in the future. However, for the DGIS to properly function as a managerial tool, specific measurement and classification standards would need to be implemented and maintained in order to eliminate errors and reduce liability.

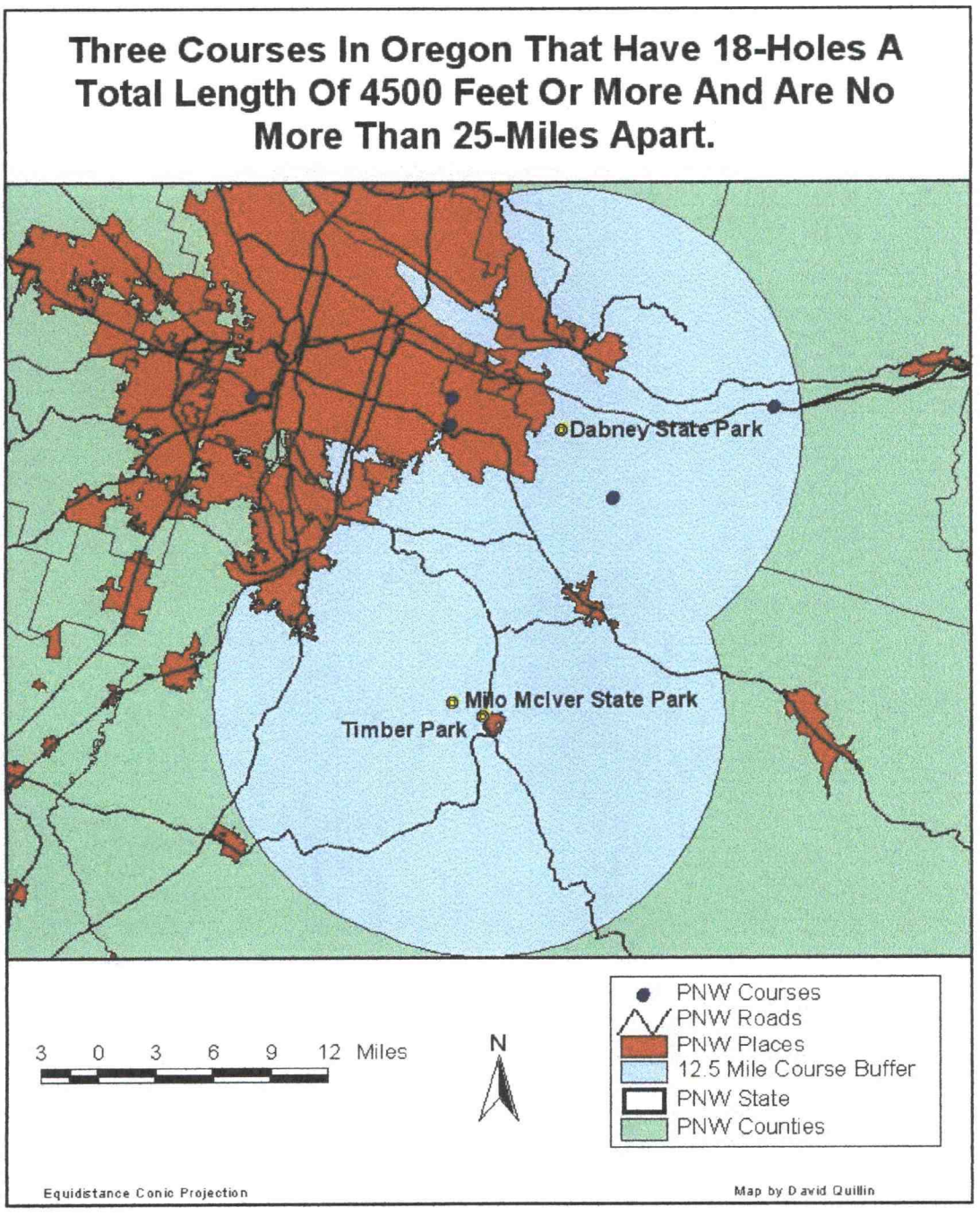
Furthermore, the DGIS would need to incorporate large scale demographic and property data for cities and towns so that accurate in-depth analysis could occur.

The Tournament Organizer

The Tournament Organizer represents those individuals within the DG recreational community who organizes and promotes its' competitive side. This group can include the player who is developing friendly competition between friends to the local clubs who want to develop internal player ratings comparable to the official PDGA membership ratings. The utility of the DGIS in this capacity lies in the scale at which it may be accessed. Locally, regionally and nationally the DGIS can be used to locate courses that meet a predetermined competition standard. By assessing the similarities and differences between courses for competitive purposes, the players' abilities can be challenged across several course settings therefore further legitimizing the rank and status that exists among the players. For example, the DGIS can be queried to locate 3 courses in Oregon within 25 mile of each other that have 18-holes and lengths of at least 4500 feet (Map 9).

However, the larger role of Tournament Organizer is one that must also be concerned with the financial responsibility of holding the tournament. Advertising the tournament and being able to present prizes and awards to the contestants and winners is a cost that must be managed by the Tournament Organizer. Player entry fees are the most common source for gaining return on this expense, however sponsorships are generally the best source of financial support. So again, in order for the DGIS to be a useful tool for the Tournament Organizer it would need data beyond simple DG course information. Large-scale facility data about local businesses that could be queried in order to find

MAP 9: TOURNAMENT ORGANIZER QUERY



potential tournament sponsors would be a useful component in this capacity. Furthermore, data on player's and past tournament participants would also be useful in that solicitation for the tournament could be directed at those who are more likely to enter

due their location to where the tournament is being held and/or level of past tournament participation.

These three personality perspectives only represent a small portion of the potential uses for the DGIS. Even within these three classes the full capabilities of the DGIS cannot currently be realized. Therefore other sources of information to be added and suggested procedures to use in the future were also mentioned. The following section will further discuss ways to implement and improve the DGIS, how best to disseminate DG information to the public and what other sources of information and data can be used to further help in the utility of the DGIS.

Conclusion

This project was done as an attempt to introduce GIS and other geographic tools into the largely unrecognized but growing world of disc golf. Because DG is relatively unknown to the mass public, little economic support is currently available for research and development. For this reason, the tools that were used to develop this model DGIS were ones that could be obtained with relatively little financial commitment on the part of the researcher. However, this caveat limits the reliability and accuracy of the DGIS for locational and analytical purposes.

In order to reduce the error that currently exists within the DGIS several procedures are suggested. The first would be to increase the spatial accuracy of the points representing the DG course by using GPS technology to gather spatial information. This researcher recorded the coordinates for the tee and pin positions of the Adair Park course, and an accurate layout of the course was depicted (Map 2). However, this process took 2-day of being in the field. Since the procedure required that each tee and pin position have

a least 30 coordinate observations recorded for each position. By having 30 observations recorded, the positional error of the tees and pins could be reduced through the averaging of the 30 observations together. This procedure also required office time for the calculation of the coordinate averages and the projection of the data in the GIS to produce the layout depicted in Map 2. The benefit of this procedure is that the tee and pin coordinates can be averaged together to produce a single point that is a more accurate representation of a DG courses' position on the landscape than may be achieved through existing methods. By improving the positional accuracy of the DGIS, the results from queries involving distances will have greater reliability.

Another improvement to the DGIS would be to formalize a comprehensive DG course development and rating system. Appendix 2 provides an example of what a course rating system might involve. Such a system might be used to create uniform attribute information about each course, reducing the inconsistencies that currently exist in the course information provided by the PDGA. By having uniform, standardized information about each course in the DGIS, useful and meaningful analysis can be performed when different courses are compared.

Finally, as a means to improve the usefulness to the DGIS as a tool for the three different personalities, better background data should be incorporated. U.S. Census Bureaus' T.I.G.E.R. files and ESRI data were used because of the ease of use and low cost of accessing the data. However, this data often proved to be inadequate in its usefulness due to the fact that attribute information was incomplete and other sources were required to locate the DG courses. For example, the road coverage only provided the major roads that are under federal jurisdiction and not state, county, and local roads.

Because most DG course are located within small communities and rural areas, the road coverage only provided a minimal amount of assistance in locating the courses. For this reason, base data that is more in-depth and rich in its attribute qualities should be used. In addition, demographic, economic, and facility data could also be incorporated to answer queries specific for a particular area (i.e. how many and what type of people are being served by a DG course?). By incorporating into the DGIS multiple types of attribute data, the usefulness of the DGIS maybe expanded to meet the needs of a larger audience because more abstract and highly involved questions could be answered.

The best way for this audience to be able to access the DGIS would be through the Internet. Currently, there are many Internet mapping tools, such as ESRI's ArcIMS software, which allow the user to receive answers to their queries in a graphical form over the Internet. With this technology, the DGIS data could be housed and managed at a central location. Through the Internet users from around the world can access and query the DGIS without actually having to have the data located on their computer. This can assist in maintaining accuracy standards and insure that the DGIS is kept up to date. Again, depending on the data available within the DGIS, this Internet mapping technology allows the different personalities to answer their questions via one source.

It should be noted, however, that with the improved accuracy of the DGIS, its increased multivariate analysis capabilities, and Internet accessibility more financial and personnel resources would be required. The GIS software, GPS equipment, Internet mapping tools, data and the hardware necessary to run them must be purchased, installed and maintained. Furthermore, on-site analysis of the DG courses must also be done in order to gather information specific to each course. However, through cooperative efforts

of local DG clubs and organizations the cost of collecting course information may be mitigated. This cooperation may also help in insuring that the DGIS is up to date and as accurate as possible.

In conclusion, this paper has explored the application of GIS and other geographic mapping tools into the recreation activity of disc golf for the purposes of developing a specialized spatial information system. The limitations that were encountered and the adjustments that needed to be made in order to develop the Disc Golf Information System were also addressed. Furthermore, this paper used three different personalities to show how the DGIS could be used and how it might benefit the recreation activity. Finally, the difficulties, errors and inaccuracies inherent to the DGIS were addressed and some suggestions were made as to how to improve these problems.

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Appendix 1: Pacific Northwest Latitude and Longitude Coordinates in Decimal Degrees

Course Name	City	State	Latitude (dd)	Longitude (dd)
Downriver Disc Golf Course	Spokane	Washington	47.6849	-117.4760
Cornwall Park	Bellingham	Washington	48.7690	-122.4790
Columbia Park	Kennewick	Washington	46.2207	-119.1400
Zintel Canyon	Kennewick	Washington	46.1908	-119.1510
Lake Fenwick	Kent	Washington	47.3684	-122.2730
Lake Stevens DGC	Lake Stevens	Washington	48.0134	-122.0530
Bicentennial Park	Mountlake Terrace	Washington	47.7914	-122.2990
Terrace Creek	Mountlake Terrace	Washington	47.7864	-122.3080
Sunnyside Park	Pullman	Washington	46.7262	-122.1900
Lake Retreat Campground	Ravensdale	Washington	47.3503	-121.9470
Lakewood King County Park	Seattle	Washington	47.5043	-122.3460
North Park	Seattle	Washington	47.7018	-122.3340
Fort Steilacoom Park	South Tacoma	Washington	47.1739	-122.5620
Riverside Park	Sumner	Washington	47.1807	-122.2200
Fort Walla Walla Park	Walla Walla	Washington	46.0490	-118.3660
Farragut State Park	Athol	Idaho	47.9734	-116.5480
Ann Morrison Park Northwest	Boise	Idaho	43.6162	-116.2250
Ann Morrison Park Southeast	Boise	Idaho	43.6162	-116.2250
Cascade Sports Park	Cascade	Idaho	44.5122	-116.0380
Pine Flats Campground	Lowman	Idaho	44.0827	-115.6270
University of Idaho	Moscow	Idaho	46.7256	-117.0140
Idaho State University	Pocatello	Idaho	42.8786	-112.4000
Lake Walcott State Park	Rupert	Idaho	42.6721	-113.4790
Freeman Park Disc Golf Course	Idaho Falls	Idaho	43.5134	-112.0530
BYU-Idaho Arboretum	Rexburg	Idaho	43.8207	-111.7820
Blackfoot Disc Golf Course	Blackfoot	Idaho	43.2017	-112.3600
Bluegrass Park - Kiwanis Disc Golf Course	Couer d'Alene	Idaho	47.7230	-116.8130
Eastman Park	Buhl	Idaho	42.6044	-114.7590
Jack Crawford Memorial Disc Golf Course	Coeur d' Alene	Idaho	47.6490	-116.7020
New Plymouth Disc Golf Course	New Plymouth	Idaho	43.9721	-116.8220
Robinson County Park	Moscow	Idaho	46.7393	-116.9630
Portland Lunchtime Disc Golf Course	Portland	Oregon	45.47348	-122.70022
Trout Creek	Corbett	Oregon	45.47940	-122.27400
Mingus Park	Coos Bay	Oregon	43.37530	-124.22700
Benson State Park	Corbett	Oregon	45.57888	-122.12750
Willamette Park	Corvallis	Oregon	44.53650	-123.25100
Milo McIver State Park	Estacada	Oregon	45.29822	-122.38292
Timber Park	Estacada	Oregon	45.29590	-122.34500
Westmoreland Disc Golf Course	Eugene	Oregon	44.02860	-123.11600
Riverside Park	Grants Pass	Oregon	42.42980	-123.32800
Tom Pearce Park	Grants Pass	Oregon	42.43430	-123.29000
Indian Mary Park	Grants Pass (Merlin)	Oregon	42.55220	-123.54200
Wolf Creek Park	Grants Pass (Wolf Creek)	Oregon	42.69070	-123.39400
Portland Adventist Elem. School	Gresham	Oregon	45.49630	-122.47400
Camp Tadmor	Lebanon	Oregon	44.48090	-122.65100
Greinfield Park	McMinnville	Oregon	45.22700	-123.27400
Wortman Park	McMinnville	Oregon	45.22410	-123.17900
Holmes City Park	Medford	Oregon	42.33030	-122.86100
Champoeg State Park	Newberg	Oregon	45.24816	-122.89429
Herbert Hoover Park	Newberg	Oregon	45.29940	-122.96800
Windsor Park	North Bend	Oregon	43.41790	-124.22300
Rockwood Central Park	Portland	Oregon	45.51560	-122.48200
Dabney State Park	Portland (Troutdale)	Oregon	45.51766	-122.35222
Riverfront Park	Roseburg	Oregon	43.21680	-123.37300
Whistler's Bend	Roseburg	Oregon	43.31350	-123.21700
Mt. Hood Ski Bowl	Government Camp	Oregon	45.29570	-121.73700
Central Oregon Community College (Cascade Forest)	Bend	Oregon	44.07060	-121.34500
Dexter Park Disc Golf Course	Dexter	Oregon	43.91780	-122.81400
Adair Park	Corvallis	Oregon	44.67673	-123.21207
Louis Creek DGC	Myrtle Creek	Oregon	43.03780	-123.19100

Appendix 2: An example of a Course Rating System

Disc Golf Course Rating & Analysis 1.1

Instructions

Course Name:	
Address:	
City, St, Country, Zip:	
Email:	**Date:**

A. Par (regular tees)	circle holes as applicable	**total**	**Par =>**	_____
Par 2 < .. 50 yds	123 456 789 012 345 678	_____		
Par 3 50 .. 120	123 456 789 012 345 678	_____		
Par 4 120 .. 180	123 456 789 012 345 678	_____		
Par 5 > .. 180	123 456 789 012 345 678	_____		
B. Tee Diversity	Tee total =>		**total / 4 =>**	_____
Level Tee Pad	123 456 789 012 345 678	_____		
20 - 30 yds prev hole	123 456 789 012 345 678	_____		
Short alternate tee	123 456 789 012 345 678	_____		
Long alternate tee	123 456 789 012 345 678	_____		
C. Fairway diversity	Fairway total =>		**total /5 =>**	_____
straight	123 456 789 012 345 678	_____		
right curve	123 456 789 012 345 678	_____		
left curve	123 456 789 012 345 678	_____		
left to right curve	123 456 789 012 345 678	_____		
right to left curve	123 456 789 012 345 678	_____		

Appendix 2: Continued

D. Terrain Diversity	total =>		**total / 13 =>**	_____
level	**fairways**	____/____	**chip shot (<30 yds)**	

uphill	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
downhill	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
right slope	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
left slope	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
mixed slopes or gully	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
smooth for rollers	123 456 789 012 345 678	____/____	123 456 789 012 345 678	
	123 456 789 012 345 678	____/		
E. Direction Diversity	max 3/direction	**total** ____	**total/8 =>**	_____
North	123 456 789 012 345 678	____/____	123 456 789 012 345 678	**NE**
East	123 456 789 012 345 678	____/____	123 456 789 012 345 678	**SE**
South	123 456 789 012 345 678	____/____	123 456 789 012 345 678	**SW**
West	123 456 789 012 345 678	____/____	123 456 789 012 345 678	**NW**
F. Putting Diversity	total =>	____	**total/4 =>**	_____
basket	123 456 789 012 345 678	____		
green complexity	123 456 789 012 345 678	____		
trap	123 456 789 012 345 678	____		
alternate configuration	123 456 789 012 345 678	____		
Course Rating	**Total (B + C + D + E + F)**			_____

Comments :

Evaluated by:

Disc Golf Course Rating and Analysis developed by Fred Chittenden
http://members.aol.com/dolfwyz/analysis.htm