golf design tools PAD VERSUS CAD: PENCIL AIDED DESIGN AND COMPUTER AIDED DESIGN

Golf construction plans have been drafted and used since the golden age. Architects like Flynn, Ross, Mackenzie and Tillinghast have left us beautiful examples of their drawings. Today, plans may be created for various reasons, including conceptual routings, hole layouts, client requirements, contractor bidding, permitting, financing, and billing, or it could be the favoured approach of the architect for land planning, clearing, rough grading, feature location, irrigation, drainage, grassing, green construction or marketing.

Depending upon the architect, client and builder, there is still room for adaptation in the field - just how much depends on the partnership. Unit pricing or engineering change orders will have an impact on the ability to amend while under construction. There are many architects who have had successful careers with nary a construction drawing, as most of their design is done in the field, working with or against the site conditions and features as they are found.

World class golf courses have been built both with and without plans. For the purpose of this article, I will describe methods that assume plans will be used. While each designer and contractor has different methods and varying levels of field adaptation, plans or no plans, the more time the designer spends in the field, generally the better the course will turn out.

Design by contours

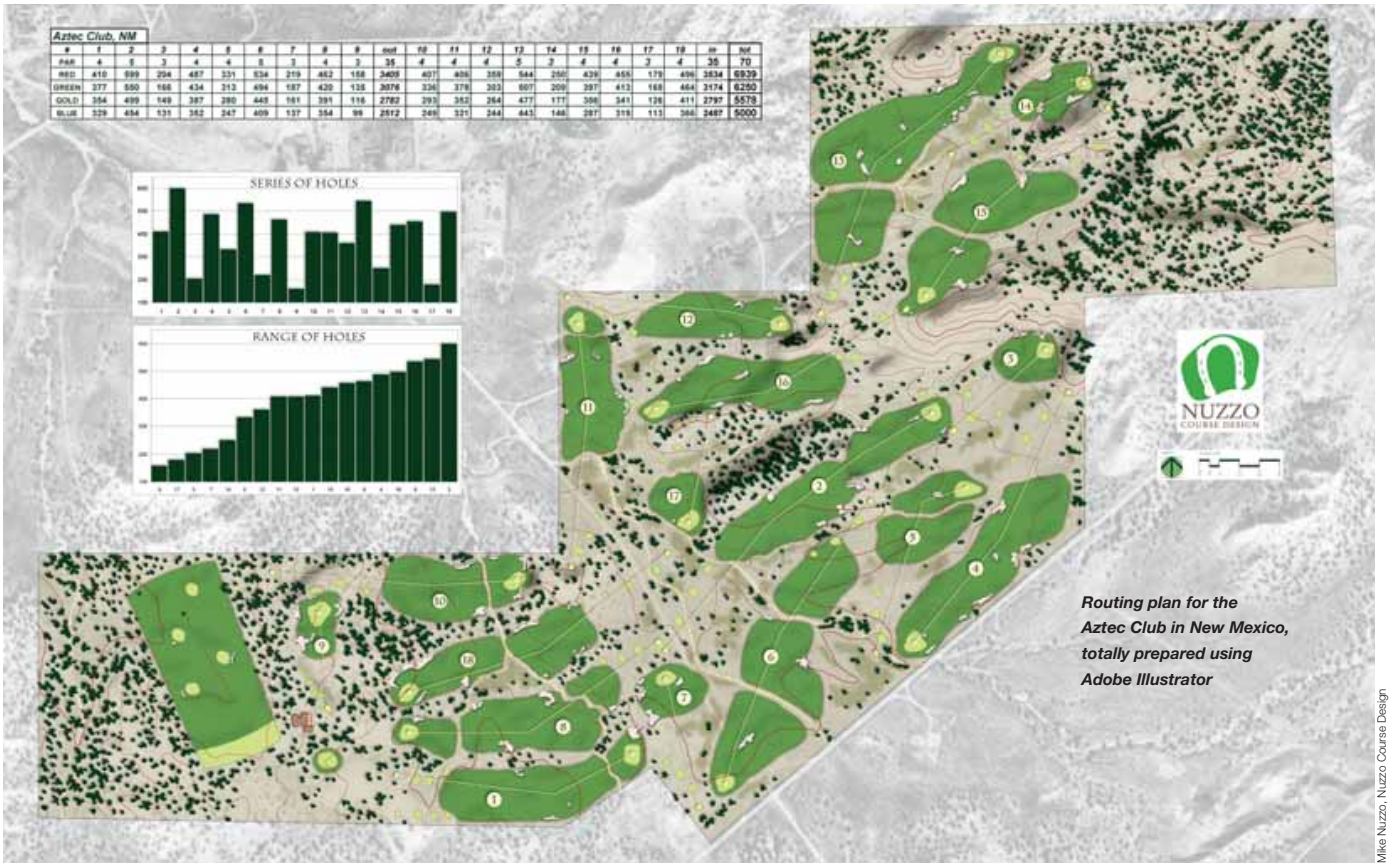
Grading plans - the language by which a contractor can build a golf course - depict the existing and proposed topographies through the use of contour lines. Each line represents a particular elevation, serving as a short-hand method for describing the topography of the land. Grading plans can be hand drawn or created on a computer using CAD. Even when drawn by hand in two dimensions, contour lines define elevation information and are similar to a wire frame CAD model and its use of contour lines.

A computer can be used to mimic the way someone designs without a computer (ideally more efficiently), or to create a new way to design. Theoretically, one new way to design would be using a program that would shape, sculpt and manipulate the land like a pile of clay while you tugged and pulled on different surfaces or nodes using a solid or surface model. A designer would be able to ignore contours and shape the land the way they'd like the golf ball to bounce, and even see an analysis of how the ball bounces. There have been advances in software in this arena, including golf game simulators such as Links Arnold Palmer Course Design (APCD) and a high-end CAD system like Autodesk 3ds Max which is used in the movie and computer game industries.

These programs have yet to prove their value in practice, as they would require improvements to easily import and export contour lines or a Digital Terrain Model (DTM) while maintaining associativity. Today 3ds Max and golf simulators are most effective as tools which enable the visualization of the golf hole or the nearest approximation of how it will look in final form. The main image in this article was created by golf visualization expert Mike Jones using APCD and this hole is also a playable three-dimensional model that can be used within the game.

Bunker research and development - without leaving the office!

Computer rendered image by Mike Jones



Routing plan for the Aztec Club in New Mexico, totally prepared using Adobe Illustrator

Mike Nuzzo, Nuzzo Course Design

If practical, once the model is complete, how do you transfer the design into the real world? The first hurdle is getting an accurate model of the existing land. LIDAR (Laser Imaging Detection and Ranging) surveys are expensive, and any site vegetation may cause minor, yet significant, discrepancies. Traditional aerial and Global Positioning Satellite (GPS) surveys are impractical to obtain the amount of data required. More often than not, the survey doesn't precisely match up to the real world - this would be critical if the intent was to eliminate the construction plan step. Hypothetically, contour plans might not need to be created, as the DTM could be processed into language the GPS receivers installed on earth-moving equipment could read, and, therefore, be able to manipulate the land without plans or staking. The last time I saw an architect present the possibilities of working this way, an experienced golf course builder on the same panel rolled his eyes, as it is presently and may always be impractical. Anecdotally, I've heard of modest success with simple shaping of tees. If you don't know what you have on the ground and you can't ensure what you make can be produced or translated, it is a fruitless approach.

My favorite use of GPS is using a tablet PC that is connected to a GPS receiver and incorporating an illustration of the golf course superimposed on an aerial photograph. As I walk a property, I can more effectively stake and flag or define the golf course boundaries and features. It was a considerable effort to put all of these technologies together, but well worth the effort as compared to the previous concept.

Individual approaches

". . . the most efficient way to design a golf course is on paper with a stubby pencil, a scale ruler, and an eraser": Dr. Michael Hurdzan's 2005 edition of *Golf Course Architecture.*

"The design process remains unchanged by technology." "It is the rest of the process that has gained speed and efficiency through the use of computers.": Ian Andrew, Ian Andrew Golf Design, Ontario.

"The most common routing method seems to be ordinary hand-sketching on tracing paper placed over base sheets": A survey of 70 golf course architects and planners in Forrest Richardson's book *Routing the Golf Course.*

Estimator for Wadsworth Golf Construction, Matt Klein, prepared a thesis in 2004 about the use of CAD, GIS and GPS in golf design and construction. It included a survey that revealed 80% of architectural firms used CAD. That said, many use CAD in combination with PAD.

A digital planimeter - the hand drawer's solution to measuring areas on plans

In order to create a digital CAD version of a hand drawing, the drawing is usually scanned and then digitized. Some might say it's simple, but it's also the reason so many CAD technicians are in the industry. It is hard to create an exact copy, as there are varying levels of scanning and digitizing depending upon the detail needed and time taken. It also requires an investment of capital and resources to hone the process to the designer's tastes.

Twelve years ago, architect Mike Young, of Young / Rymer Designs, employed Bobby Root to develop a golf-specific layer on top of Bentley's MicroStation for Young's own use. It had the ability to automatically create a bill of materials (BOM) for grassing, cart paths, irrigation pressures, drainage and more. It also automatically created hole centre lines as you clicked from tee to turning point to green. This software became known as T2Green International. After significant in-house development, Root tried to sell program copies to other architects. Root eventually sold the system to Jack Nicklaus, who now owns the software and employs Root while he constantly upgrades the program. Young still prefers to route on a paper topographic map, manipulating templates, then hand-drawing, scanning and digitizing to create a digital representation of his layout.

Some design directly into a computer and have modified their approach to fit within the constraints of a CAD program. Many, like architect Ken Dye of Finger, Dye, Spann, choose to create entirely without the use of a computer. His construction documents are all hand drawn and extremely detailed. Scale, eraser, tracing paper and coloured markers for renderings are the tools of his trade. The most technical tool would be the planimeter used to measure areas for accurate earthwork computations. Architect Tony Ristola coined the term 'Pencil Assisted Design' (PAD) in his pictorial essay for Paul Daley's *Golf Architecture Volume III*. He creates a hand-drawn perspective sketch to help convey to the client and contractor the final form the holes should resemble. Architect Mike Strantz's, who recently passed away, was a master of the beautiful hand drawn illustration (example below centre).

A 25-year industry veteran once asked me how I erase and how I use a scale. Fortunately, a computer has the ability to skip steps, one of which is using an eraser. When I draw a line using my digital pencil, instead of erasing the part I don't like, I just redraw it, and the computer assumes I meant to redraw that portion. It has a setting which fine tunes that ability, or it can be turned off completely, and you can use a new modern form of an eraser if desired.

Regarding scales, I created and use several types of golf-specific drawing tools. I use a circular concentric ring scale (spaced at 100' intervals, around 30 metres) located at the tee or landing area to determine carry distances. I turn on and off a grid at any scale, which becomes automatic variable graph paper. I employ a manually drawn graph paper element when I wish to have the plans look more traditional, like a Flynn or Ross original. Any kind of hole template can be dragged and nudged across an aerial map of the property for routings. Lastly, I use some small circle guides to quickly measure slopes. For me, Illustrator also works great for preliminary or conceptual routings working over aerial images, including working with easements or wetlands. Some of these tasks can be automated using a more rigid CAD program, but to me, creativity is most important at these stages and drawing freehand allows for the most inventiveness. There are some differences that require adaptation. CAD works in real space (one metre in the file equals one metre on site), while a drawing program works like hand drawing in that document scales are used, as there is a limited paper size. Importing and exporting CAD files is possible, but it does require some effort and diligence. Keeping updated with the latest version of the program is significant with a new version coming out about every 18 months.

No matter which method is chosen, every hour the designer spends on the details is another hour of thinking about how the design will work in the field. Choosing a design method is complicated, as there is nothing exactly like the profession of golf course architect, just as there is nothing like the game of golf.

Computer rendered image by Mike Jones

Mike Nuzzo, Nuzzo Course Design

A hybrid approach

"What has not changed in the past decade or two is that designers make lousy computer operators and computer operators make lousy designers".
Mike Hurdzan's 2nd edition of *Golf Course Architecture*

Is it possible for someone to do both, and do them well? Graves and Cornish in their book *Golf Course Design*, stated that *"golf architecture is an art form practiced by imaginative and innovative people"*. Being a designer means having the ability to envision, and I turn my visualizations into artistic drawings with the computer monitor as my canvas.

I have spent considerable time devising my plan creation methodology (a cross between hand drawing and CAD) and by using Illustrator, a vector-based illustration program, whatever I think, whatever I draw, is immediately digital. Having used this, and a similar program for more than a decade, I find it to be far more efficient than CAD or hand drawing. For my own work, I use two large flat panel monitors and a large Wacom pen tablet ideally suited for drawing free form contour lines.

Above from left to right: Rugged Dune - a digital golf course created and played in Links Arnold Palmer Course designer / A hand drawn sketch by a gifted illustrator and architect like Mike Strantz provides an evocative image of the finished product / A work station environment used by the author with twin screens and a graphics tablet, mimicking hand drawn methods in a digital world.

by Mike Nuzzo

Mike Nuzzo is an American golf course architect based in Houston, Texas, who has a particular interest in applying digital design and rendering methods to golf course architecture.