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GAMEROOM

May 2007 Volume 19, Number 5

www.gameroommagazine.com

\$5.95

Do It Yourself!

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One Man's Adventures in Constructing His Own Completely Unique, Made from Scratch Pinball Machine

by Jeff Mathews

A few years ago we moved from Boston, Massachusetts to Lyons, Colorado. Lyons is a small mountain town which sits only an hour from the Continental Divide's Trail Ridge Road. This road crosses the heart of the Rocky Mountain National Forest and at over 12,000 feet it's the highest continuous paved highway in the United States. Our town is understandably known as *The Gateway to the Rockies*, but probably lesser recognized for holding one of the highest pinball per capita ratios in the Nation. With about 150 pinball machines and only 1,600 residents, the town currently boasts of nearly one machine for every 10 people.

Thankfully, a good portion of the town's pins are in public service. I'm speaking of course about the meticulously maintained machines at Kevin and Carole's *Lyons Classic Pinball* arcade. Visitors come from all over to play these museum quality machines at very reasonable prices. Having grown up to Pac-Man pattern gaming, I don't recall playing much pinball when I was a kid. But after a few visits to this arcade and some quality talks with Kevin I now consider myself a fledgling PinHead. I was indoctrinated on machines like Gottlieb Haunted House and 300. I found there is an analog, magical, ethereal romance in the lights, sounds, wood, and metal of these machines.

It wasn't much longer before there were machines at home — then in a new game room at work. I soon had the pick of seven free play machines. This meant it was time for a real challenge. I'm an embedded systems engineer by day. I design the control software and electronics for the systems that run

everyday things: automotive engine management, cell phones, wireless access points, and even fancy coffee machines. With a wood-working hobby and the help of many friends and family, I was sure I could... construct my own pinball machine from scratch!



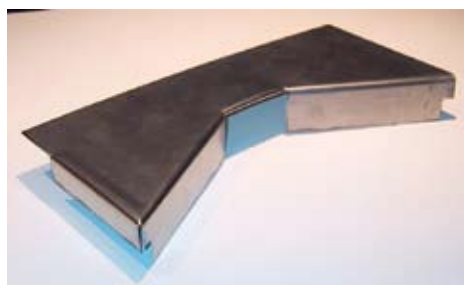
In the Winter of '05, I conceived the idea of building a 3/4-scale pinball machine after being disappointed with plastic pinball toys for my kids. It would be a multidisciplinary effort wrought with difficulty and expense but worth the effort. The primary goal of my project was to make a true, complete, and locationable pinball from scratch. I wanted to make it clear that it was created from the ground up and this fit well with the scheme to fabricate it to 3/4-scale for the kids. Its

size gave birth to the name for this scale — I called it the TweenPin series.

I've found that there are people interested in the construction of their own custom machines, but most have had only the opportunity to change the artwork on an older machine. Artwork is core to creating theme and really completes a game, but to me the real interest is in the control system. Having the ability to build a custom control system, means being able to control any number of toys, playfield arrangements, or rule sets.

From the start I wanted only new components for this machine. Sourcing electrical and electronic components was not at all difficult. For example, the cabinet's main power supply and control board is constructed from all new components. However, pinball specific assemblies were another matter. I spent quite a bit of time talking to just about every parts supplier I could. Eventually I learned what parts could and couldn't be designed into a one-off game. For example, sourcing new and complete drop target assemblies would be pretty much impossible. What was unusual and difficult about my approach from my parts supplier's point of view was that I was not shopping for replacement parts on a specific machine. Instead, I was shopping for complete assemblies based on their function and appearance. It reminds me a bit of going to the parts counter at your local auto dealership and asking to dig around in the back, just to look for parts that seem interesting, without knowing your car's model or make.

The arrival of the pinball assemblies inspired a quick sawing out of the cabinet



and playfield. After which I turned to routing the playfield. I fabricated acrylic templates for the playfield inserts and hand routed the playfield with a fluted bit. Using two different template guides and depths I achieved an acceptable shelf at each insert location. After some fine tuning, the inserts went in easily and still didn't allow light around their edges.

The actual name of this particular finished machine is "Cabin Fever." The artwork depicts a cabin in the woods, a bear, and so forth. The bear head is the primary attraction and the only toy in the machine. If not for the head, the cabinet would have been designed like a 70s pin, where the glass is parallel with the playfield. The head opens and closes with the assistance of the control board and a hobby servo. Inside the painted playfield mouth is a traditional Gottlieb style capture hole mechanism. After knocking out all of the "BEAR" targets, the bear head opens, the mouth is lit, and the arrow target flashes indicating the bear bonus is available. When the ball is captured in the mouth, the bear "chews" the ball a while, and then it spits it back out. Knocking down the "LOG-JAM" targets increases the bonus multiplier. This is where the real points are. And just for fun, when the multiplier exceeds the limit, the machine goes into Crazy Mode where the sounds change and the flipper buttons reverse. This mode was inspired by the flexibility of our control system and my desire to keep games shorter during shows; however,



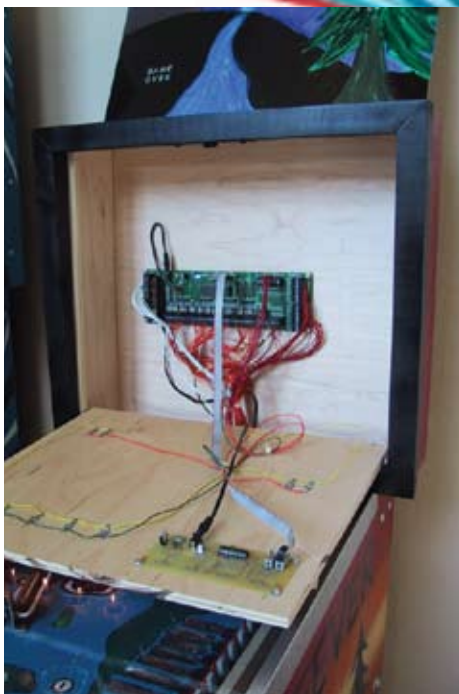
I hear there is something similar in the 2003 Simpsons pin.

I decided to fabricate all my plastics from 3/32" polycarbonate (generic Lexan). This material is usually reserved for protection washers. Constructing templates was a matter of templating with cardstock, routing, sanding, polishing, and painting. The plastics around the bear head are a single piece, a fairly complex plastic that doubles as target cover, bear arms, and strike protection for the assemblies inside the head's mouth.

I fabricated the metal parts that were highly custom. The odd size of the machine meant a good deal of extra work. The machine is only 30" tall from floor to lockbar and the playfield is only 18 x 33". This meant I needed one-off legs, rails, lockdown, spinner and guide lanes. Thankfully my father, a mechanical design engineer turned marketing executive, had some time to figure out these components and had access to a full machine shop.

For this machine, I refused design changes that I felt would lessen the romance of a pinball machine. It would be steel, wood and glass, not plastic, and it would have incandescent bulbs, not LEDs. However, I did make a few modern optimizations. I feel they are appropriate given the year of construction and furthermore, I like to think I carefully honored the historical progression of pinball into these choices. For example, I wired the flippers only on their high current lugs. The control board itself uses a timer to switch that single coil winding from a full "hit" to a pulsed "hold" current. An end-of-





stroke switch is not needed.

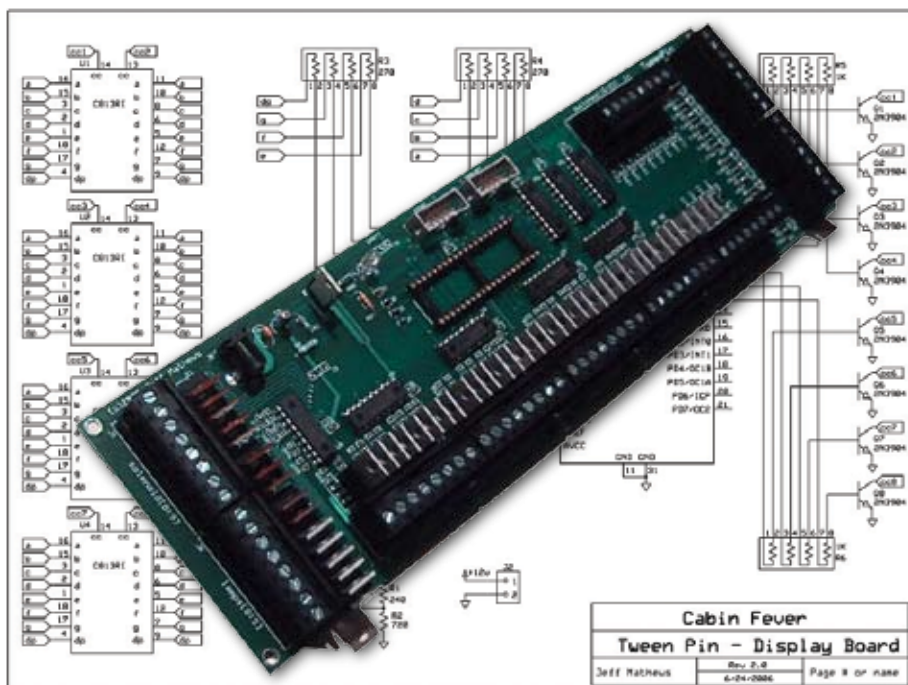
The backbox exterior is much like that of an early '80s Gottlieb machine, but to avoid the complexities of the traditional hinging and latching mechanisms, I instead opted for a '90's style backbox lock. The backglass slides out through a slot in the top allowing the backbox panel to swing down on hinges revealing the control system.

The machine's heart is a modern, lead free, control board and software system, designed and built here in Lyons, Colorado. I feel that a pinball machine is a perfect example of a real-time control system. As such, it should function with a dedicated embedded control

system.

The good news was that since I was designing and constructing my own control system, I was free to do whatever I could imagine. I was completely free to design the playfield in any fashion I desired. I could integrate whatever electromechanical assemblies I could find and I could control the rules, the solenoids, and the whole system. It was here that my creativity could run amok and I could do whatever I wanted.

What are traditionally separate boards requiring nearly two square feet of area, I combined into a single custom circuit board with over 80 external connections. The power regulation, rules, lighting, switches, pop bumper and flipper control are all handled through a single 12" x 4" control board and its speedy embedded software. There is no opportunity for those interested in the fine art of programming language and operating system debate, since the software is so simple. It is written in C, without either an operating



system or esoteric pinball language.

Contrary to the fixed assignments normally seen in your pinball machine schematics, we did not even bother with a formal assignment of solenoids, lamps, and switches. When we first powered up the machine, the game was playing absolutely crazy. The target switches would directly activate the knocker and flipper buttons were controlling pop bumpers! With the unlimited adjustability of our custom control system only a few simple software changes were needed to quickly resolve these oddities. The system also easily accommodates a myriad of coils and electromechanical assemblies from various suppliers.

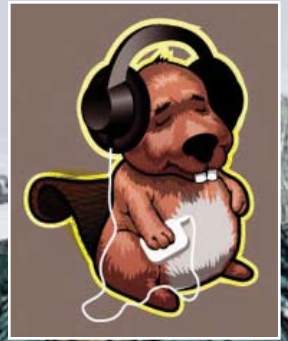
There are a few changes we'll be making for my future machines. Cabinet construction was surprisingly straight forward, but a move to a high quality European Baltic birch plywood seems to be in order. The 3/4-scale of this particular machine meant I couldn't utilize many standard parts from other pins. For future machines, I'm seriously considering more complex displays and sound. It would also be interesting to integrate some electromagnets and more unique and complex toys.

We've already started on our next machine, full size and full of fantastic ideas. Thanks to our first efforts and the '06 Pinball Expo, we've made some great contacts. We're now consulting with several current and former industry players. We'll be play testing our first whitewood at the local arcade which is chock full of serious players. We expect to wind up with about a dozen of these very fun, unique games. **GR**

Special Thanks

Luckily this project was either magnetic or crazy enough to have drawn in the help of my family and many friends. Special thanks to our kids, Molly and Snow (Tween inspiration), my perfect wife Amy (art and support), my mother Anita (support), my father Mark (mechanical design and metal fabrication), Bob Kornoff (woodworking tools), Lee Taylor (partner & awesome code monkey), Randy Willig (electronics consultation), Tom Karpeichik (woodworking consultation), Pete Moffitt (welding and metal fabrication), local artists Jeani Spahr (hand painted playfield) and Craig Knaak (back-glass and plastics).

diy pinball



DIY Pinball hosted a seminar on the construction of custom machines at the 2006 Chicago Pinball Expo. If you missed DIY Pinball there, you can catch them at the Rocky Mountain Pinball Showdown in April of 2007. Jeff and Lee Taylor are planning on introducing custom pinball machines for the avid collector and kits for the do it yourself pinhead. If you're interested in building your own pin or contributing to the designs of their next machines, they are looking for your input. Please drop a line with your suggestions, ideas, and requests to jeff@diypinball.com.

