Larry Benko, W0QE 2/5/2013

Electronic Design for the Hobbyist

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Reason for the Presentation

- The Boulder Amateur Radio Club May/November homebrew nights are very popular and represent a wide range of topics
- This presentation is to encourage more homebrewing and to increase skills
- Thanks to those (21) who responded with suggestions in the past month

- Common adage:

  “If you’re not learning then you are dying”

Scope of Presentation

- Hobbyist?

  A single person doing all aspects of electronic design guarantees being a hobbyist in some area!

- Please make comments during the presentation
- Please make notes as to any topics that could be dedicated future presentations

Topic Limits of this Presentation

- NO… One of a kind, 40 year old, large $ items
- Everything must be available to everyone
- Emphasis on
  - Low or no cost & educational value
  - Spending time equates to spending some $
- Presentation is not comprehensive due to time
- Primarily aimed at electronic projects: analog, digital, microcontroller, RF. No antennas, & no mechanical construction due to time

Project Life Cycle

- Decide on project
- Design
- Simulate
- Procure parts
- Construct
- Debug & test
- Analyze
- Document, save as PDF (e.g. Bullzip or other free)
- Brag!, Don't brag if you skip any of the above

Basic Electronics Design

- ARRL Handbook, ~$50
- All About Circuits, free virtual electronics book
- RF Circuit design, Chris Bowick, free download
- Online electronics courses, free
  - MIT course 6.002x, Circuits and Electronics
  - ElectronicsTheory.com, basic course
  - Many on YouTube etc.

Web Resources

- G3YNH zdocs, Amazing resource by David Knight
- YO3DAC-VA3IUL, many good RF links
- Huge amount of good material online but the Internet also contains a lot of bogus information

Electrical Simulation Programs (all free)

MicroCap10, Microwave Office, Ansoft very powerful & expensive

- Spice, from Berkeley University (the original)
- LTSpice IV, from Linear Technology,

  huge user group & files, see other Linear Tech. simulation programs
- QUCS, v.0.0.16, Quite Universal Circuit Simulator

  Win, Linux, AC/DC + S-parameter analysis

Electrical Simulation Programs (all free)

- Tonne Software, Elsie, OptLowpass, SVCfilter, Diplexer, Helical, PI-EL, etc. (write LTspice files)
- Almost All Digital Electronics, Filter Design
- Duncan's PSU Designer II, power supply design

Current Smith Chart Programs

- SimSmith v7.6, free, Win, Mac, Linux
  - needs free Java Runtime Environment (V7 update 13 or later), actively updated and supported
- Rfdude Smith Chart v0.810, free, Win,
  - last update 2007
- Quick Smith v4.2, free, last update 2009
  - Doesn't run on Win7-64, See Jul & Sep 2010 QEX,
- WinSmith 2.0, SuperSmith2.09, MicroSmith, No longer available
- SimSmith hands down is the best!

Calculators RF Oriented (all free)

- SWR Calculator, Win7-64 OK, old but very useful
- EEWeb Tools, several nice web tools including inductance & impedance calculators
- ON4AA Inductance Calc, web based, very accurate & other good stuff
- Dual Dielectric Coax Calculator, web based
- Coax Loss/Power Calc, web, Times Microwave
- Mantaro Impedance Calc, web, many physical structures
- mini Ring Core, toroid calculator

Major Parts Suppliers

Sell to anyone with a credit card or PayPal

- Mouser Electronics
- Digikey Electronics
- Allied Electronics
- Newark Electronics
- Avnet Electronics
- Future Electronics
- Arrow Electronics

Finding Parts

- Find Chips, several distributors stock & buy
- Octopart, several distributors stock & buy
- IC Master, more part types but less useful

- Above websites make a good vendor list
- Prices vary 40% or more
- Many suggestions about low/high cost vendors didn't match my experiences. Check what you buy!

Other Parts Suppliers

- Parts manufacturers & reps
  - TI, Maxim, Linear Tech, etc. very good at sampling,
  - Enter design contest and answer surveys
- Jameco
- NTE Electronics, replacement components
- All Electronics
- Radio Shack, depending on store

Specialty Parts Suppliers

- Kits and Parts dot Com, toroids, small RF parts
- eBay, bus. & industrial category, (Chinese parts?)
- Amidon, toroids, special tape & wire
- Dan's Small Parts, assortment of mostly RF parts
- SchmartBoard, SMT IC adapters
- Micro-controller stuff later

Construction

- SMD, thru hole, or mix?
- Solderless, dead bug, ugly, Manhattan, generic PCB with holes/pads, project specific PCB?
- Evaluation or proto-board (common for uP/DSP) or PCB design re-fabs for anyone
- Prototyping examples from Clifton Laboratories
- Ugly construction examples
- PCB front panel (SMD)
- Magnification need is proportional to your age!

Schematic Capture

- "Back of envelope" or handwritten in notebook
- Generic CAD program, Autocad, Visio
- ExpressSCH, from ExpressPCB

  Schematic and PCB layout, free, schematic output OK, $60 for Gerber files, easy to learn
- PCB Artist, from Advanced Circuits, free
- Schemeit, from Digikey, Web based schematic only,

  free, nice looking schematics, includes vacuum tubes
- TinyCad, basic schematic drawing

Semi-Pro Schematic Capture

Schematic capture linked to PCB layout, Gerber files (Cadence & Altium powerful & expensive)

- Eagle (Element 14), free light ver., 1 schematic sheet, Win, Mac, Linux, program not intuitive
- DipTrace, free for 300 pins or 500 if ask
  Win, Mac, Linux, very flexible
- KiCad, free, Win, Mac?, Linux,
  generally considered inferior to Eagle or DipTrace
- DesignSpark, free from RS Components/Allied

PCB Design

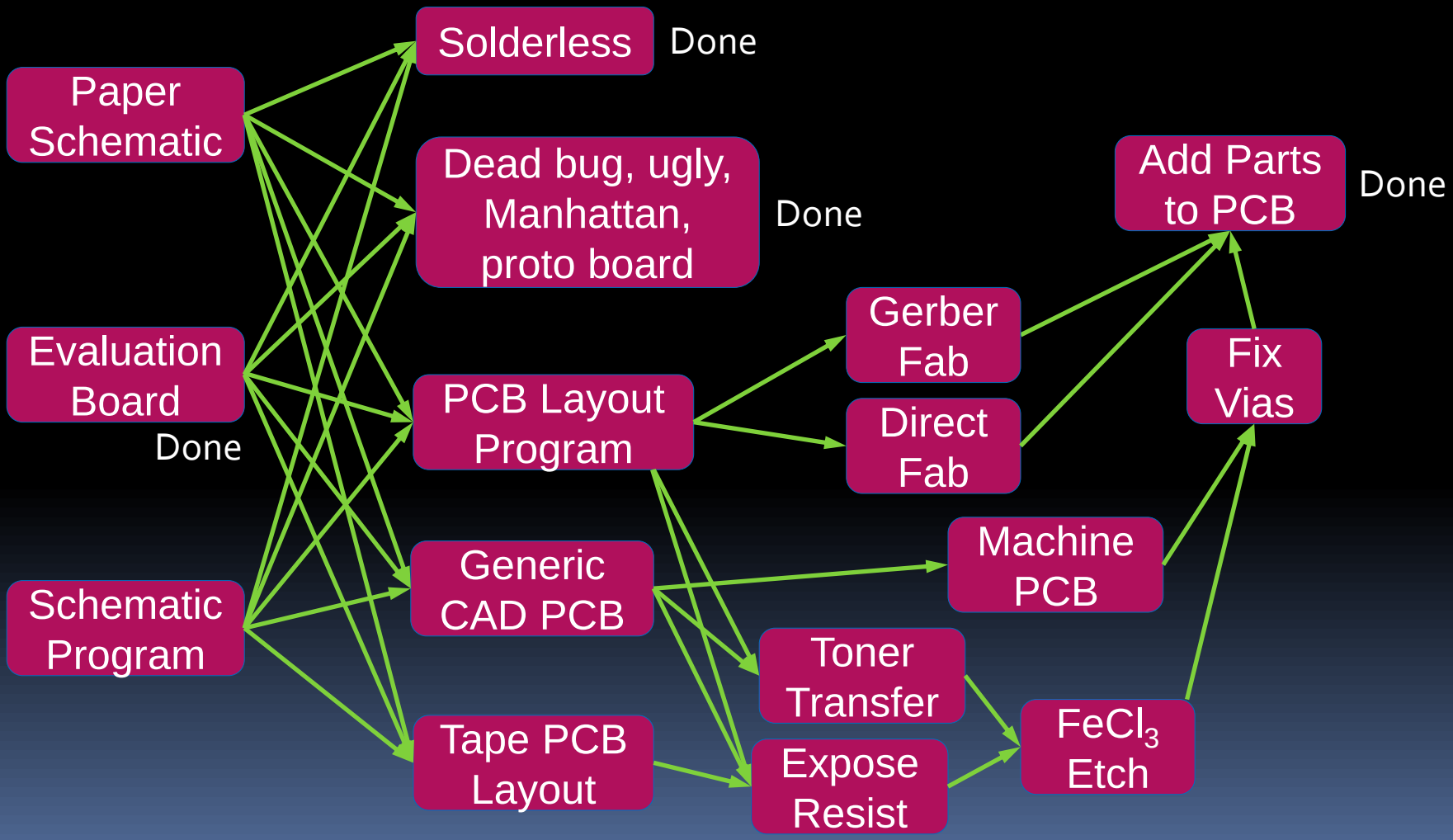
- ExpressPCB, free, easy to learn, PCB size limits
- PCB Artist, Advanced Circuits, free
- FreePCB, free, net list import
- Eagle, free for 2 layers, 4”x3.2” PCB
- DipTrace, free for 500 pins/2 layers, $125 for 1000 pins/4 layers

- PCB Vendors, LadyAda summary
- Cheap PCB discussion, Element 14 Community

Post PCB Design

- FreeDFM, Advanced Circuits, get discount with use
- Most vendors have some checking software
- Panelize or not?
- Batch vendors such as BatchPCB, OSH Park, etc. (no need to panelize), very cool, $/in^2
- Local companies such as Circuits West and Advanced Circuits (aka 4PCB, $33 PCB etc.)
- PCB4U, Accutrace, $10 ea. x 10 (<20 in^2) + $10
- Electrical test, probably not!

So Many Choices!



Microcontroller

- Small computer on a single integrated circuit
  - Usually mixed signal with flexible I/O
- Different than a microprocessor
- Functionality repurposable based on code, compilation, programming of device
- Very useful device in many electronic designs

Microcontrollers Excel for the Following

- Debouncing switch inputs & encoder processing
- 10-12bit A/D, Complex timing events > few uS
- Async. serial, SPI, I^2C, USB data
- Driving simple to medium complex displays
- PWM driving motors & LEDs
- Counting frequency to ~60MHz
- Simple math & register control for DDS etc.
- Power frugal designs
- Does this sound useful for a project?

Microcontroller Choices

Broad category and very large topic

- Arduino, very popular $25+ (Atmel AVR), shields
- PIC, huge # of parts, all time most popular ~9B
- MSP430, lowest power, $4.30 LaunchPad, Stellaris ARM LaunchPad $12.80
- ARM, very fast, licensed to many suppliers
- Mini PCs: Raspberry PI, MK802IIIS, Beagle Bone, OLinuXino-MAXI, run Linux or Android
- DSP, DDS, FPGA etc. design similar

Microcontroller Development (typical)

- Pick microcontroller family
- Get development board
- Download part datasheet and other docs.
- Download compiler/editor/programmer/debugger*
- Get programmer if needed (in or out of circuit)
- Write code (learn assembly language or C etc.)
- Debug code

Microcontroller Project Sources

- SparkFun, electronic projects, classes
- Adafruit, electronic projects, Limor Fried named entrepreneur of year 2012 by Entrepreneur Mag.
- Olimex, small uC PCBs, sold by US distributors, Sparkfun, Adafruit, & Microcontroller Pros
- Direct from manufacturers, often free shipping
- Arduino parties and clubs
- Arduino language reference
- TI LaunchPad CC110L 2 radio & BP-EDUC-01

Open Source Hardware and Software

- Dangerous Prototypes
- Seeed, open source facilitator
- Sharp LCD, graphics low power displays
- SparkFun, Adafruit, Micro Center etc.
- Energia, Arduino like environment for MSP-430

Debug and Troubleshoot

- Digital multimeter, more than 1
- Various power supplies
- Oscilloscope, 2/4 channels (digital?)
- Function generator (sine/square/pulse wave)
- Component meters (LCR + Q)
- RF signal generator
- RF power meter, dummy load, attenuators
- Spectrum analyzer
- Vector network analyzer

Inexpensive VNAs

- DG8SAQ VNWA & new VNWA3, kits and assembled versions, Jan & May 2009 QEX
- Array Solutions VNAs , W5BIG (AIM 4170C, 4170UHF, VNA2180) and Rig Expert (AA-30, AA-54, AA-230, AA230PRO, AA-520, AA-600, AA-1000)
- mini Radio Solutions, IW3HEV miniVNA
- N2PK VNA, mostly craftsman kit
- Don’t forget calibration loads

Other Test Equipment

- LC Meter IIB, measure inductors and capacitors
- Blue ESR Meter, find bad electrolytic capacitors
- HV probe, clamp on RF probe, clamp on AC/DC current meter, lots of DC & RF cables
- Good soldering equipment, magnification, microscope, hot air rework, hot plate, oven
- Test equipment capture to a PC very desirable

RS-232 programs

- HyperTerminal no longer free after WinXP
- Clear Terminal v2, free, basic, v1 was simpler
- RealTerm v2, free, hex, I^2C
- Putty v0.62, free
- Docklight v2

  free eval. with saving/logging disabled, monitors both sides of serial stream, hardware cable & 2 ser. ports

Documentation

- Often unfortunately overlooked
- Electronic schematics, well commented code, screen shots of measurements etc. go a long way to document the project and are easy to do
- Pictures at various stages of the project
- Parts list
- Description of project use similar to a manual
- Project specs

Helping & Getting Help (Important!)

Want to help someone remotely or need help

- See remote PC screen & take control of PC

- Person helping sees remote PC screen as a window
- Person helping can have optional control of remote PC
- Person being helped sees local screen as usual and controls access

Screen Sharing Software (free)

Need mouse control & do not need remote access

- RealVNC v.5, free for private use, no encryption
  - fastest, requires opening port(s) in router for server, maps multiple monitors as one, Java mode very slow
- join.me, free for non-commercial use
  - easiest to setup & use, moderate screen refresh, handles multi-monitors well
- TeamViewer v.8, free for non-commercial use
  - fast screen response, has both remote control & meeting modes, handles multiple-monitors well

What's Next?

- This is a great time for electronic design!

- What's next?
- Presentation of some topics at a much more detailed level
- Topics that were skipped?

- Hope the information was useful

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