

Innovation & Design and Modern Engineering Entrepreneurship

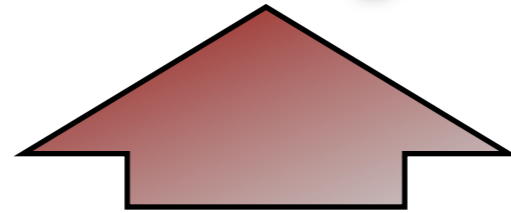
Prof. Bruce Jacob

Keystone Professor & Director of Computer Engineering Program
Electrical & Computer Engineering
University of Maryland at College Park

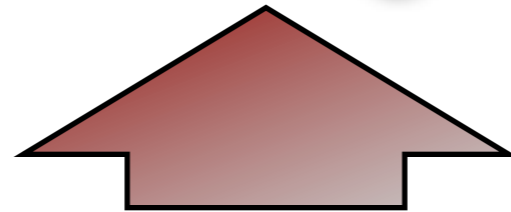


The Point

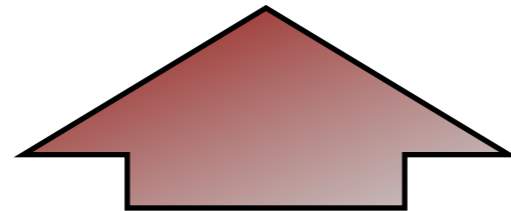
all individuals in society become wealthier



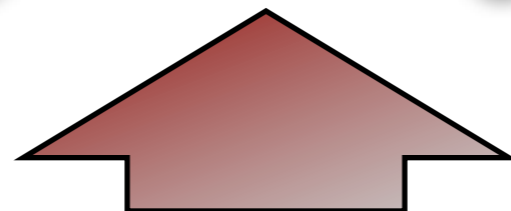
economic growth



innovation



good design



???

The Point

Innovation creates Wealth

For you

For others (beneficiaries of your innovations)

For the economy

Wealth is **not** like energy;
it obeys no laws of conservation

The Point



Wealth



Not Wealth

The Point



Wealth



Not Wealth

The Point



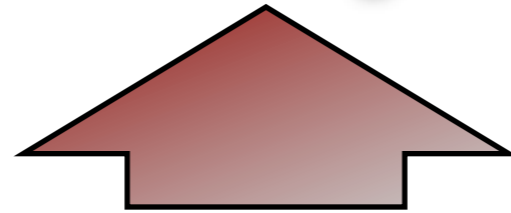
Wealth



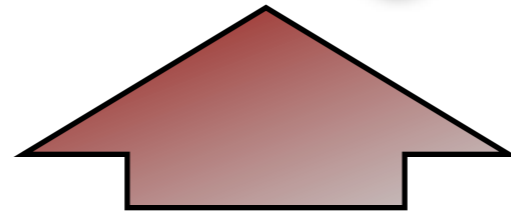
Not Wealth

The Point

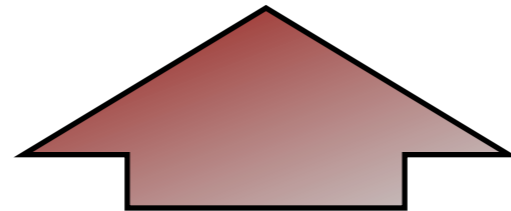
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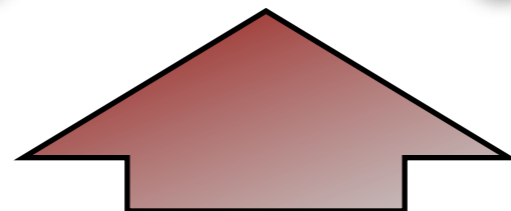
economic growth



innovation



good design



???

It's All About Innovation ...

“Innovation and trade: the ultimate engines of growth.”
—*Economist*, Oct 3, 2009

“We have to choose to do what past generations have done: shape a brighter future through hard work and innovation.”
—Barack Obama, Sep 22, 2009
(ASEE’s “Obama Touts Innovation Agenda At New York Community College”)

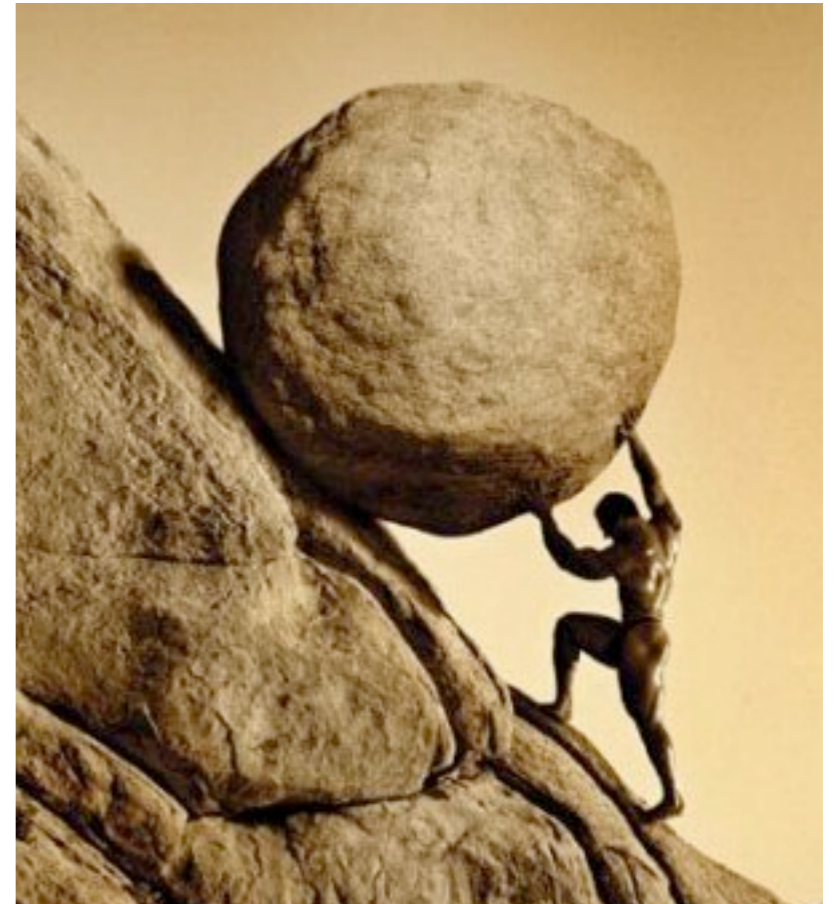
“In the new knowledge economy, innovation and knowledge are the most important factors driving economic growth.”

—Progressive Policy Institute: *The Innovation Economy*, Oct 2003

“Innovation is the heart of economic recovery & future prosperity.”
—*Roll Call*, Nov 20, 2008

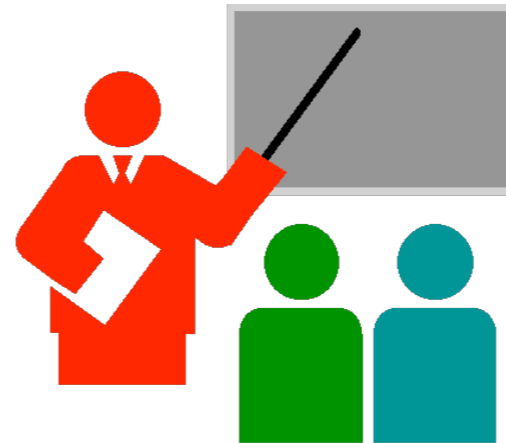
... But, Boy, Is Innovation Hard

- “In an era when most technology outfits have tightened their belts to adapt to a slower-growing market, one company stands out for forging ahead on innovation: Apple Computer.” (*BusinessWeek*)
- “Big companies are losing their ‘A’ players, and they’re struggling to attract ‘B’ players. In an industry where everything is about people, large tech companies are in trouble because they are losing the talent war. And keep in mind, an ‘A’ player in an organization can usually produce the same results as three ‘B’ players.” (*VentureBeat*)
- “Lots of companies have tons of great engineers and smart people. But ultimately, there needs to be some gravitational force that pulls it all together. Otherwise, you can get great pieces of technology all floating around the universe. But it doesn’t add up to much.” (*Steve Jobs, on innovation*)



Some Issues I Would Like to Address Today

1. Despite what we may think, we don't really teach it here



2. How can you instill it in your business partners/employees?



3. Why #2 matters to you (yes, you)

Talk 1: Thoughts on Teaching Design

What is Design? What is Innovation?

- Can't define it, but you know it when you see it ... 😊
- Close interaction with **burnout** phenomenon in start-ups
- An inability to eat, think, sleep, care for one's self while technical problem remains
- Requires staring at one problem for extended period (much like Ph.D. in that regard)



Let's Look More Closely at that Last Bit

- *Innovation and design requires staring at one problem for extended period*
- Contrast that with academia (undergrad in particular):
 - Attention flits from topic to topic in a scheduled, often frenetic pace
 - Semester concept is both arbitrary and contrived/artificial (innovation recognizes no schedule)



Larry Ellison



Bill Gates



Stephen Spielberg



Richard Branson



Michael Dell



Steve Jobs

Is it any wonder that SO MANY successful entrepreneurs/innovators dropped out of school?

Teach Innovation Despite Scheduled Frenzy?

Necessary Elements:

- Look at one problem for extended period (years?)
- Personal investment in outcome (reward, pride, etc.)
- Time commitment need not be large on per-week basis
- Need to see **real examples** of both success and failure
- Must be guided by innovators (not academicians, not MBAs)
- Failure is acceptable (grades)



Olin College, est. 1997

More on Grades

Students calculate the effort needed to get the desired (or lowest acceptable) grade.

They do the minimum work required.

We (unconsciously) **train them** to do this.

Needless to say, this doesn't fly for design.
In design, anything less than full attention = failure.

What Are We Doing?

- Electric Guitar Design Class
- MIPS: sponsored R&D
- Innovative engineering designs
- Coil LLC: Commercial venture involving students

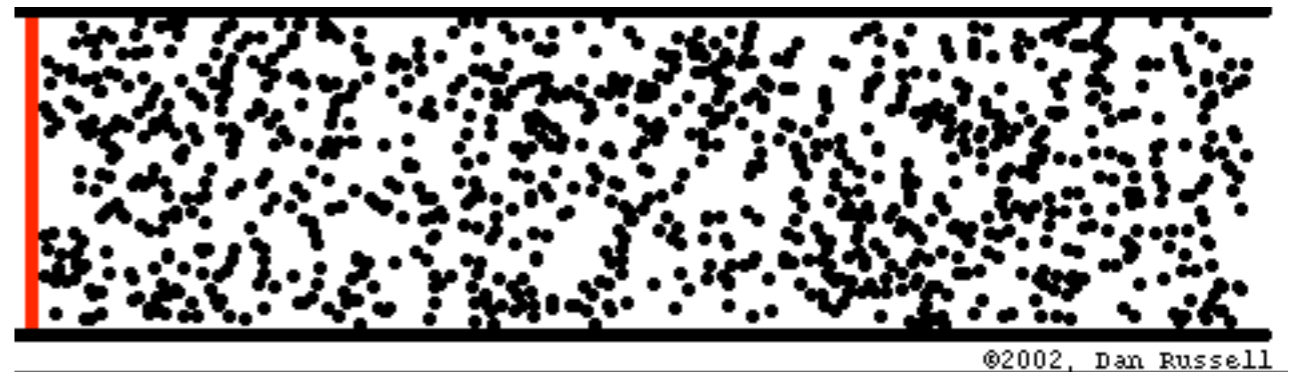
What Are We Doing? (You know, besides PR ...)

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What Are We Doing?

- **Electric Guitar Design Class**
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The Physics of Sound

What Are We Doing?

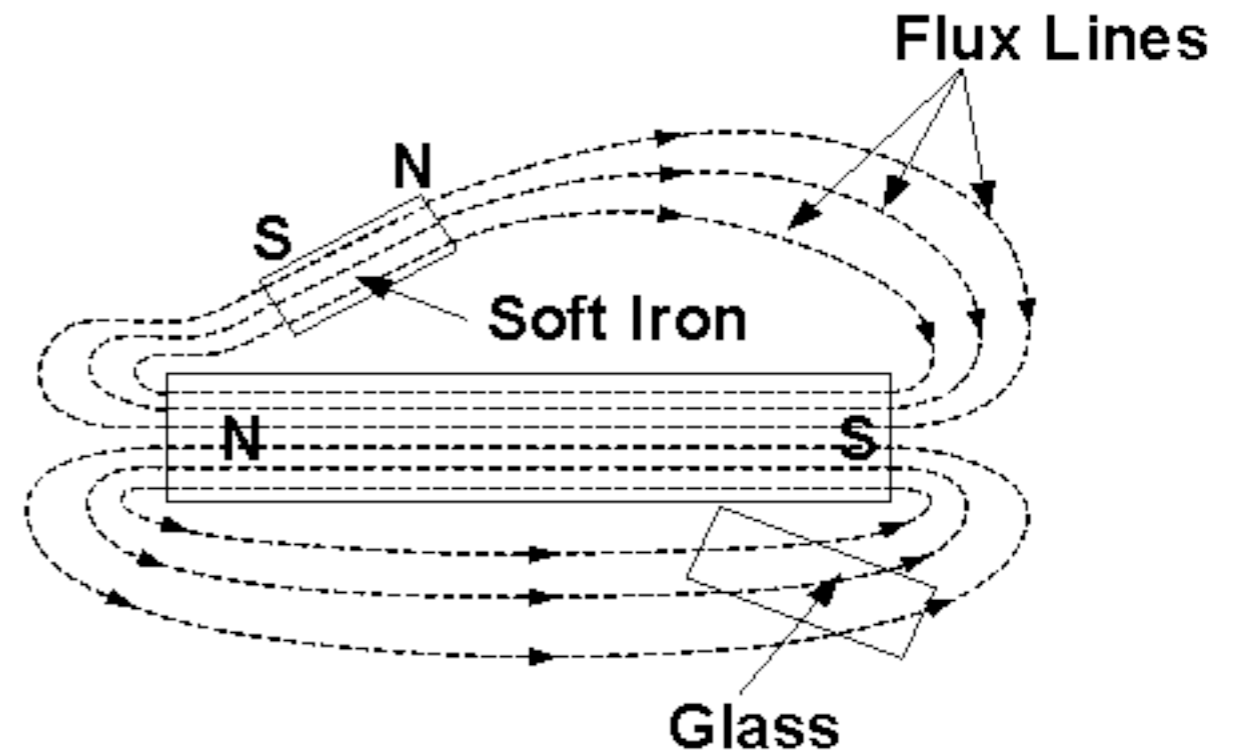
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The Physics of Sound

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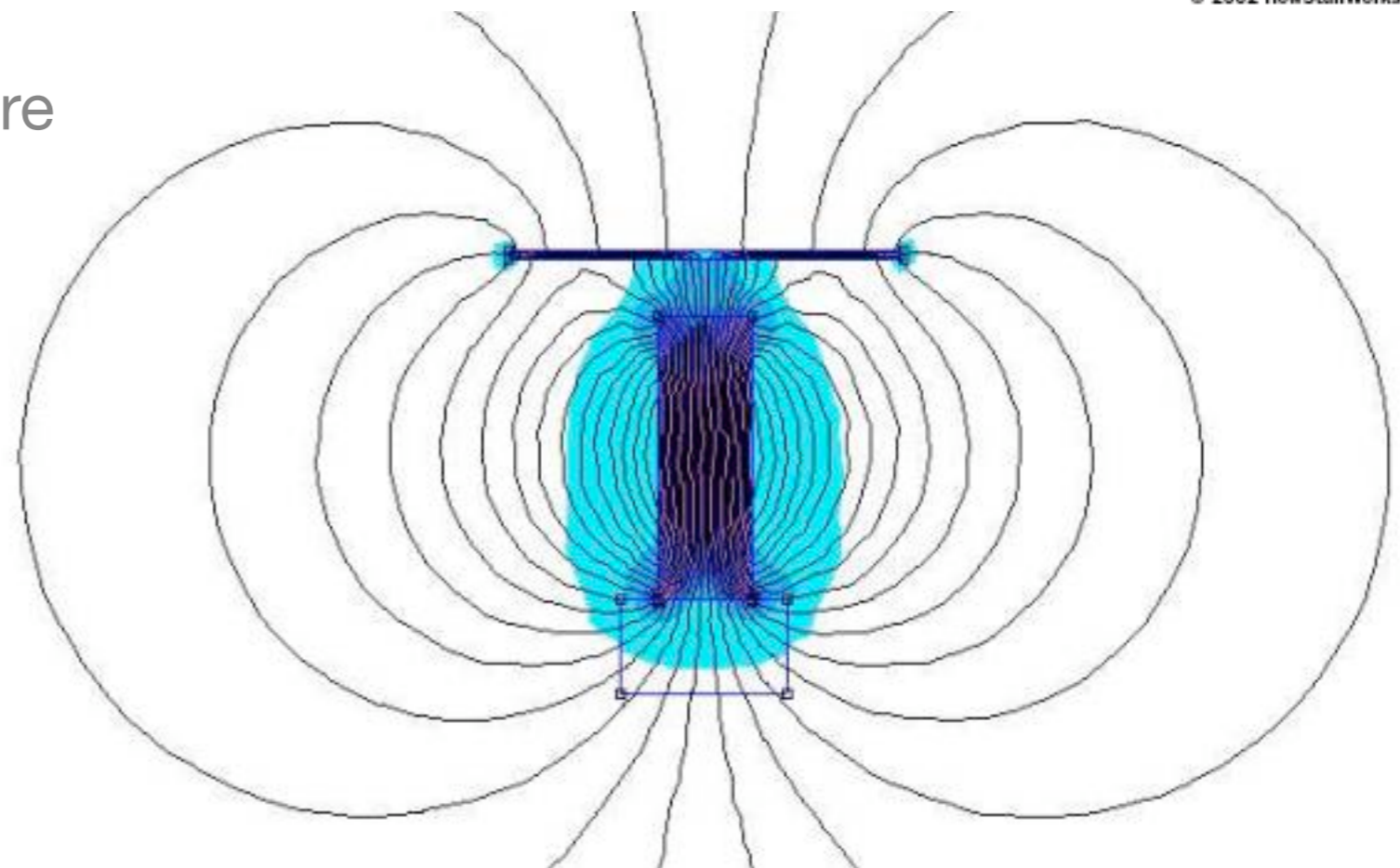
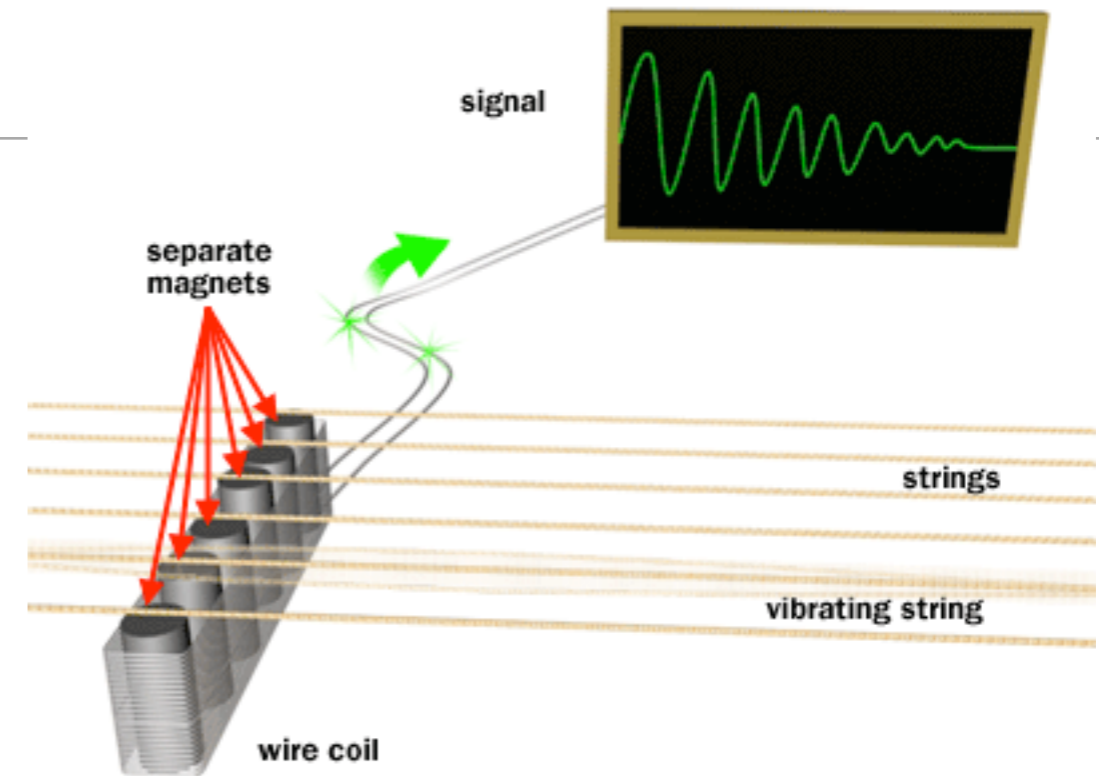
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Iron in a Magnetic Field

What Are We Doing?

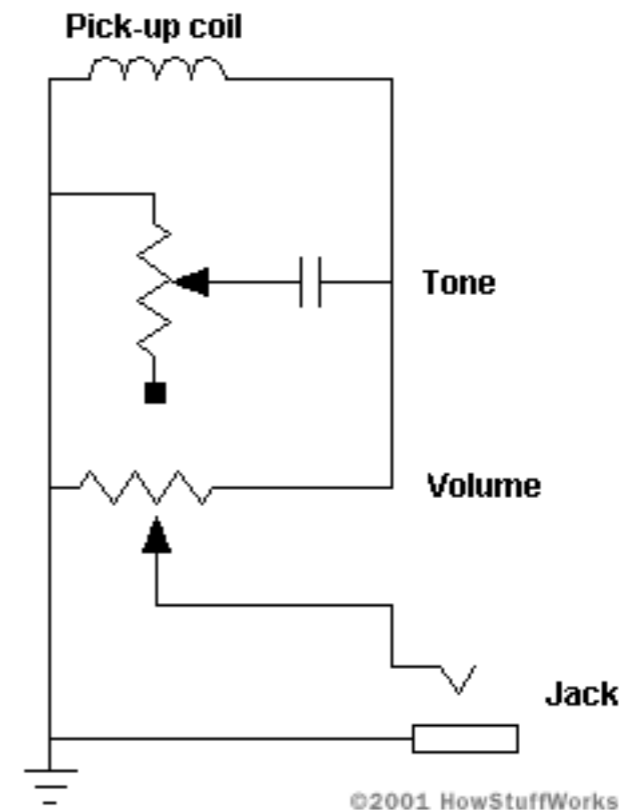
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How a Pickup Works

What Are We Doing?

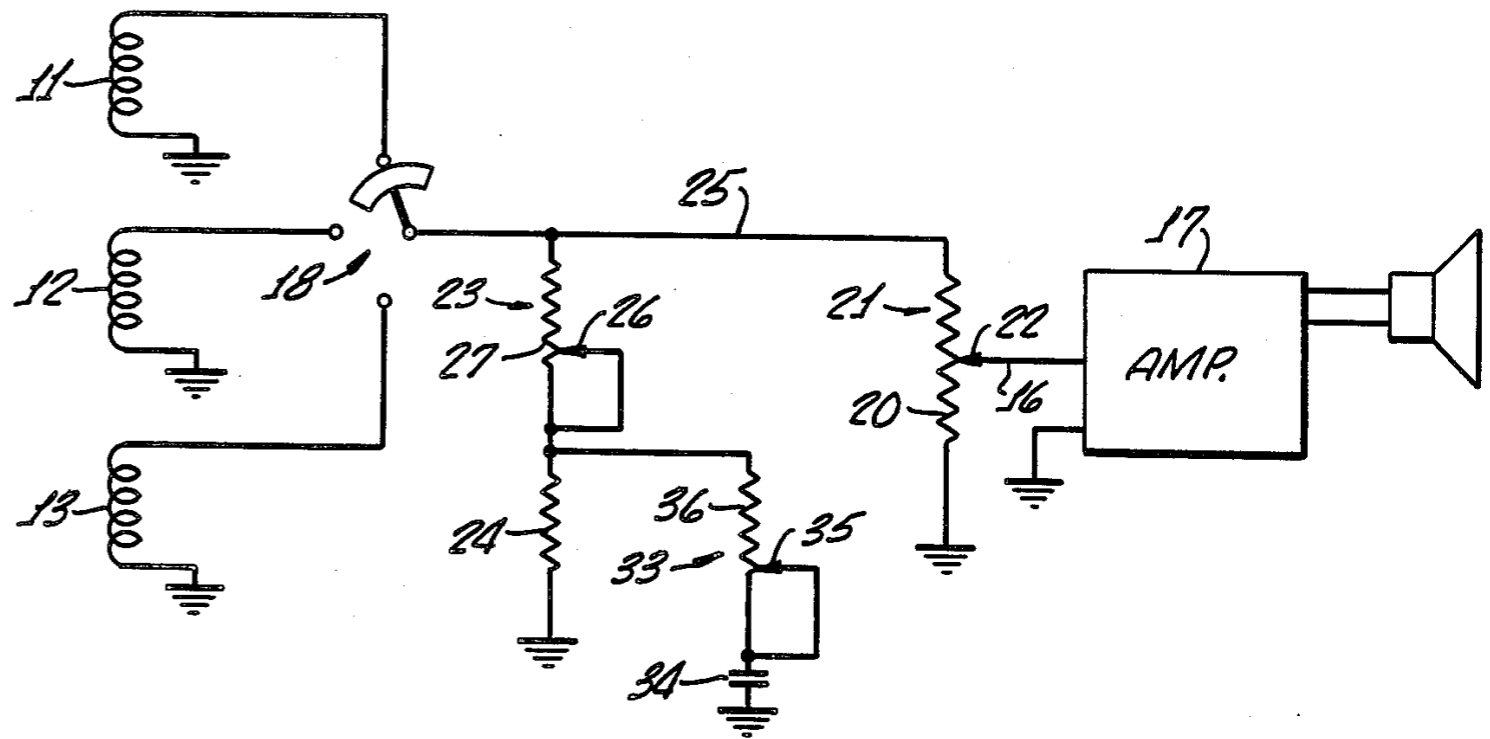
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Basic Electric Guitar Circuit

What Are We Doing?

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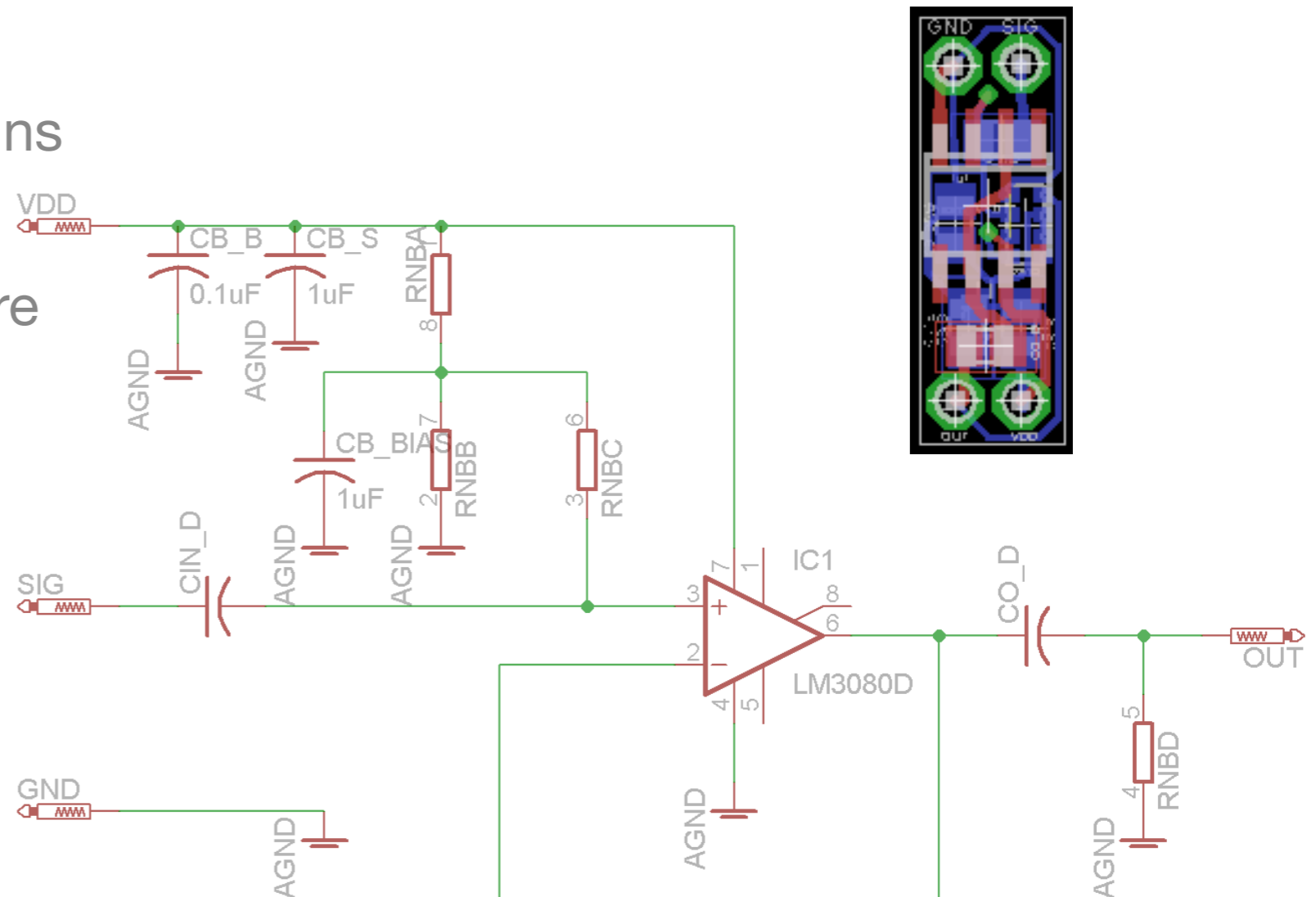


Basic Switching Circuit
(Fender-Style *and* Gibson-Style)

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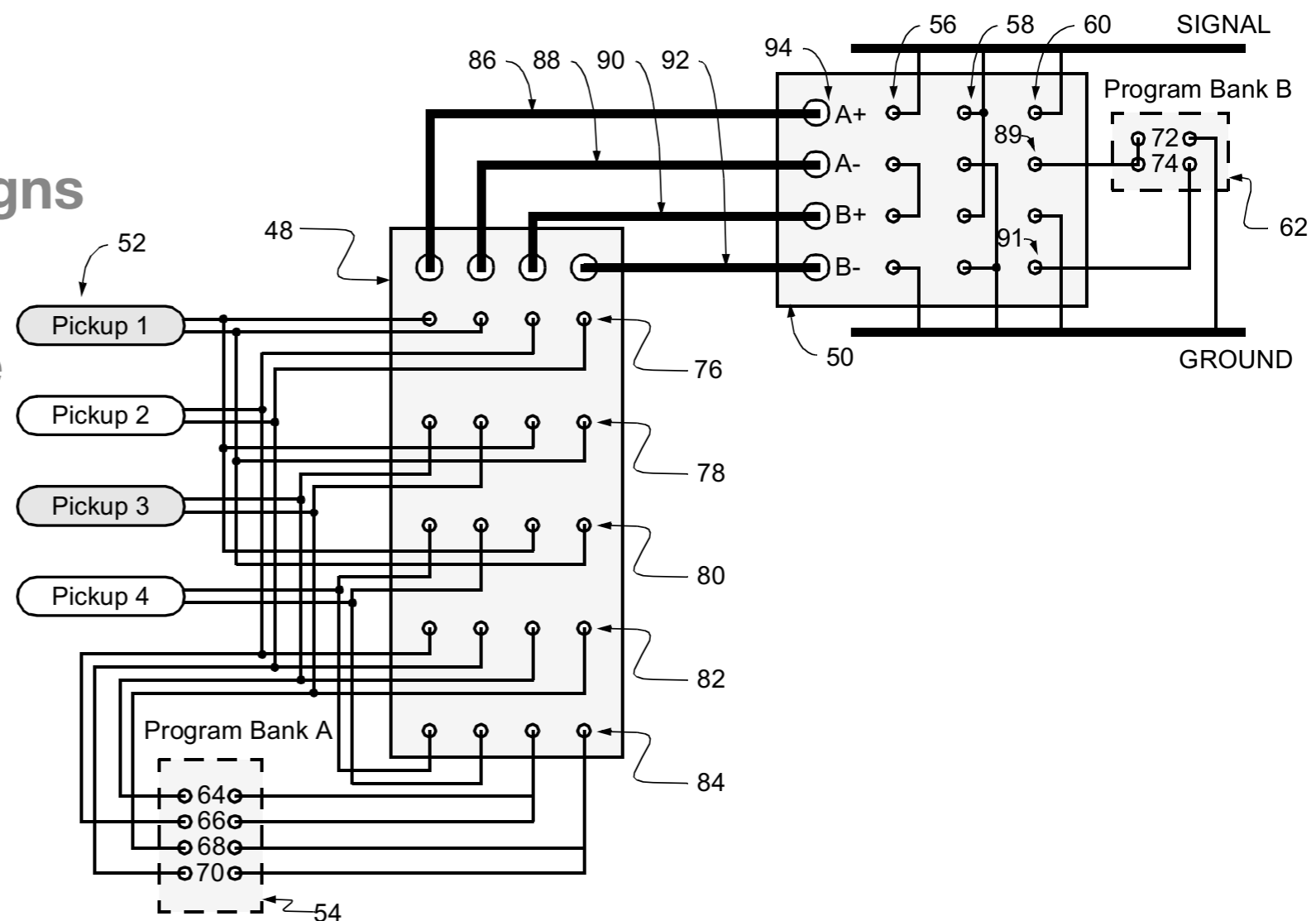
Preamp Design for Active Cables



What Are We Doing?

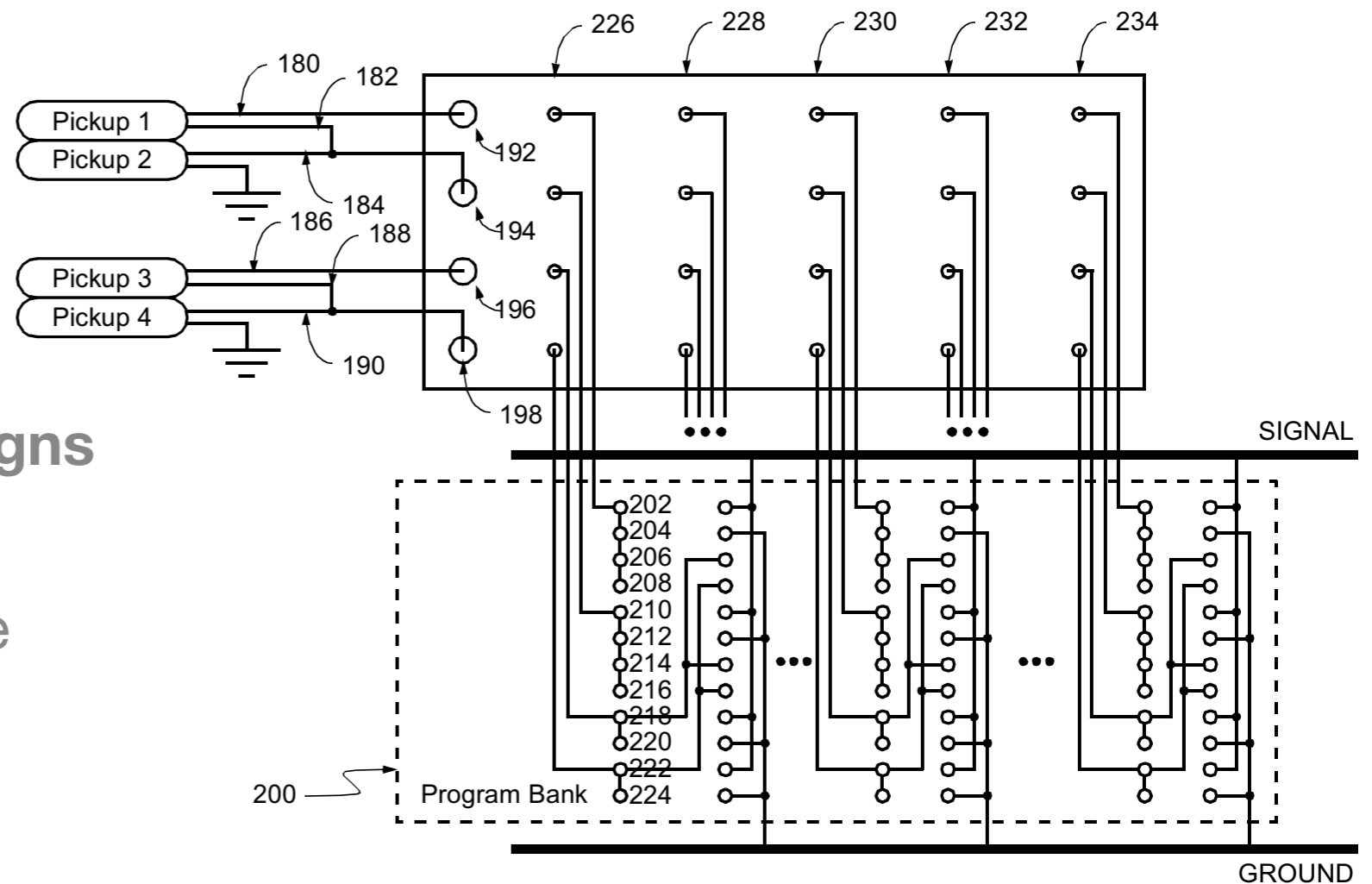
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Switching Patent (one type)



What Are We Doing?

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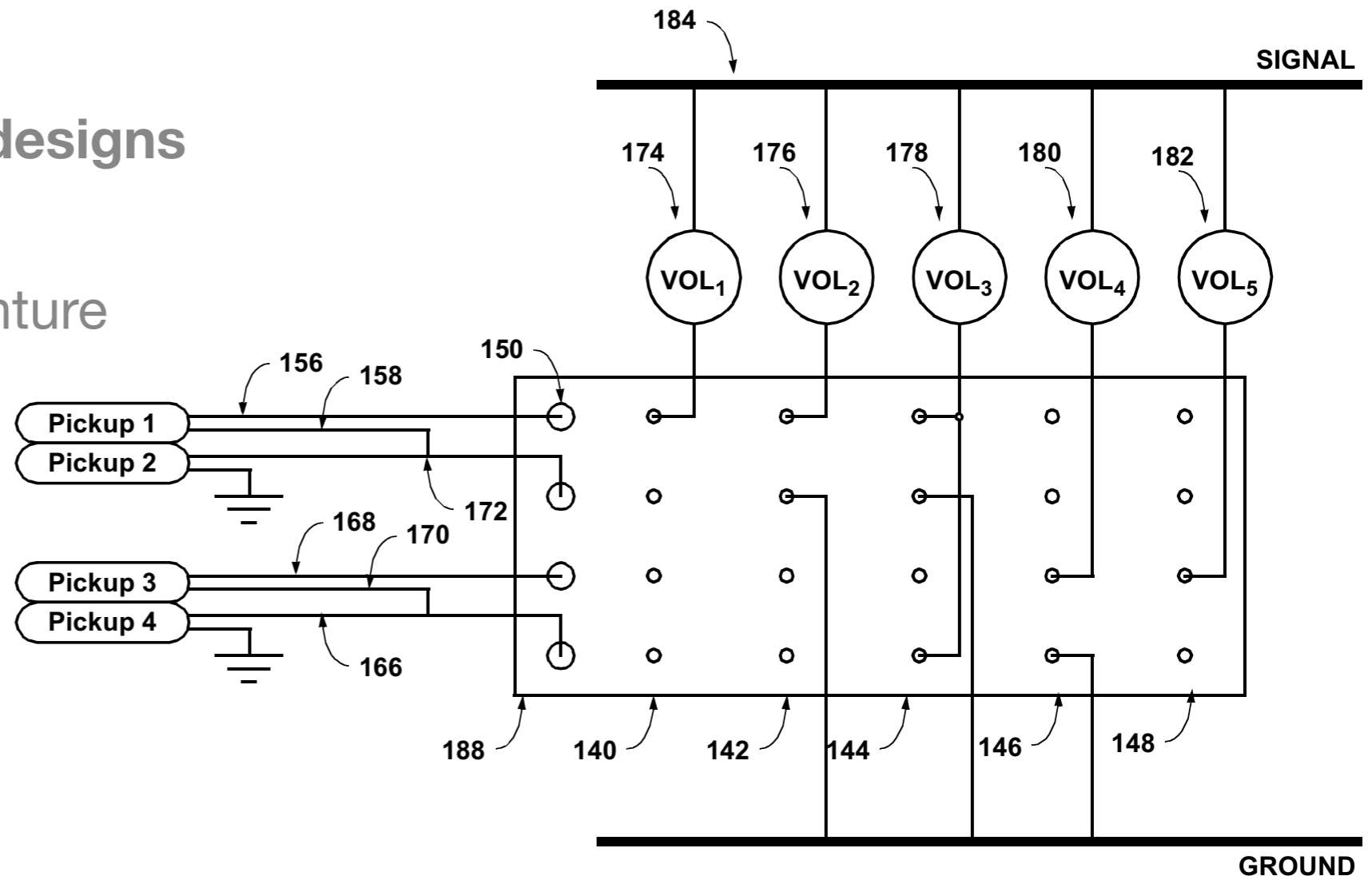


Switching Patent (another type)

What Are We Doing?

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Volume Patent



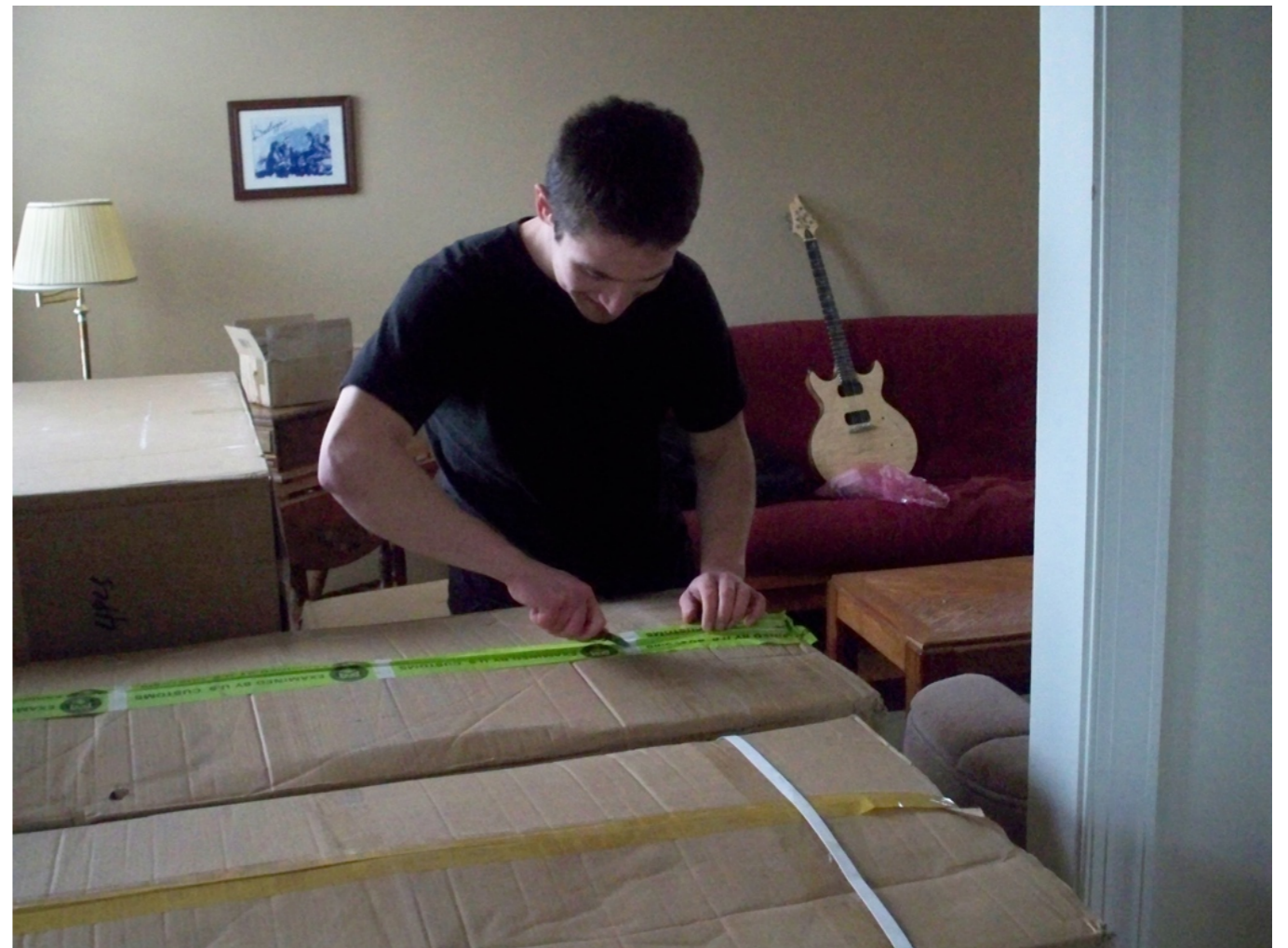
What Are We Doing?

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What Are We Doing?

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How do you make them care enough to do it right?

Talk 2: Innovation and the Lion's Share of Reward

The Problem

Innovation.

Specifically, *How to Do It in a Business Setting*

... and, you know, like, *regularly* ...

Some Perspective

Big companies cannot innovate, whereas startups **must**.

Startups are engineer-dominated; **founders** (engineers) are rewarded for company's success.

Upon maturity, startups become management-dominated; **executives** (non-engineers) are rewarded for company's success.

(thus #1, above)

Goal: break this cycle

"Paul Graham's prose is brimming with contrarian insight and practical wisdom."

—Andy Hertzfeld, co-creator of the Macintosh computer

PAUL GRAHAM

HACKERS & PAINTERS

BIG IDEAS FROM THE COMPUTER AGE



Some More Perspective

Middle managers believe themselves innovators.

“Intrapreneurship” (also termed “corporate entrepreneurship” or “corporate venturing”) tries to foster creativity within corporate environment.

Most studies empower middle management. None investigate rewarding engineers. WTF?

The term *managerial creativity*, a common term in the research literature, probably says it all.

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The Problem, Again ... and a Solution of Sorts

Either you do everything yourself,
or you have partners/employees.

Assuming the latter, how do you
instill in others the desire to do
good design?

How do you ensure that your
company innovates?

How to get partners/employees
to go above & beyond on a
regular basis?

*How do you convince the
exceptionally talented that it is
worth their while to work for you
instead of for themselves?*



Arrange it so that they **are** working
for themselves.

Reward: Become a *De Facto* Startup

Novel concept:

Pay your engineers as if they are in a startup

Good managers, scarce though they may be, are no scarcer than good designers. Great designers and great managers are both very rare. Most organizations spend considerable effort in finding and cultivating the management prospects; I know of none that spends equal effort in finding and developing the great designers upon whom the technical excellence of the products will ultimately depend.

Fred Brooks (*The Mythical Man-Month*)

If You **Are** a Startup

Not-so-novel concept:
Have every partner buy in



Bottom Line

- Existing trend is to study innovative exceptions (Apple, Google, Fiat, etc.) and try to emulate them.
- Why not emulate an entire **industry** instead? In particular, the one industry known for **innovating** regularly.
- What do startups do? They recognize that engineers are their primary innovators, and they **PAY** them.



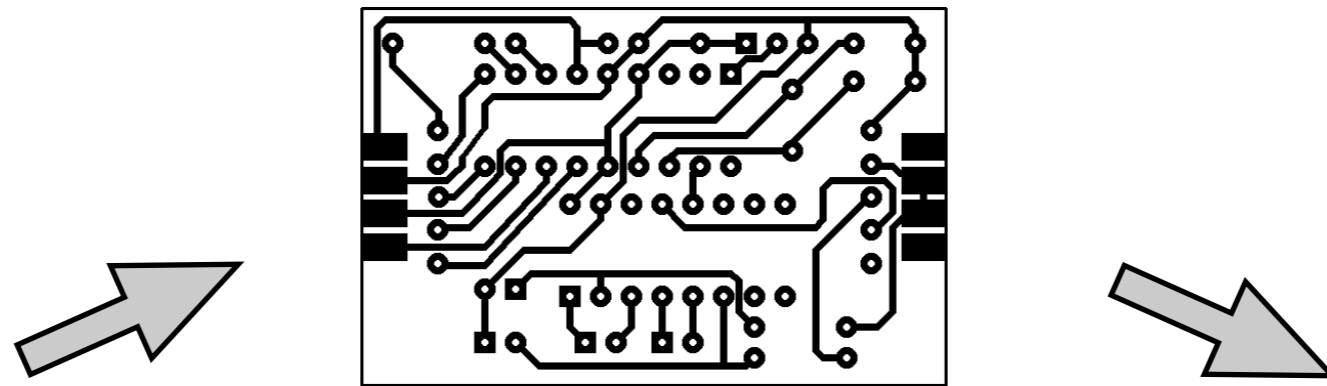
Innovation = Wealth

Talk 3: Design and Modern Entrepreneurship

Important development in last decade:

Manufacturing as a Service

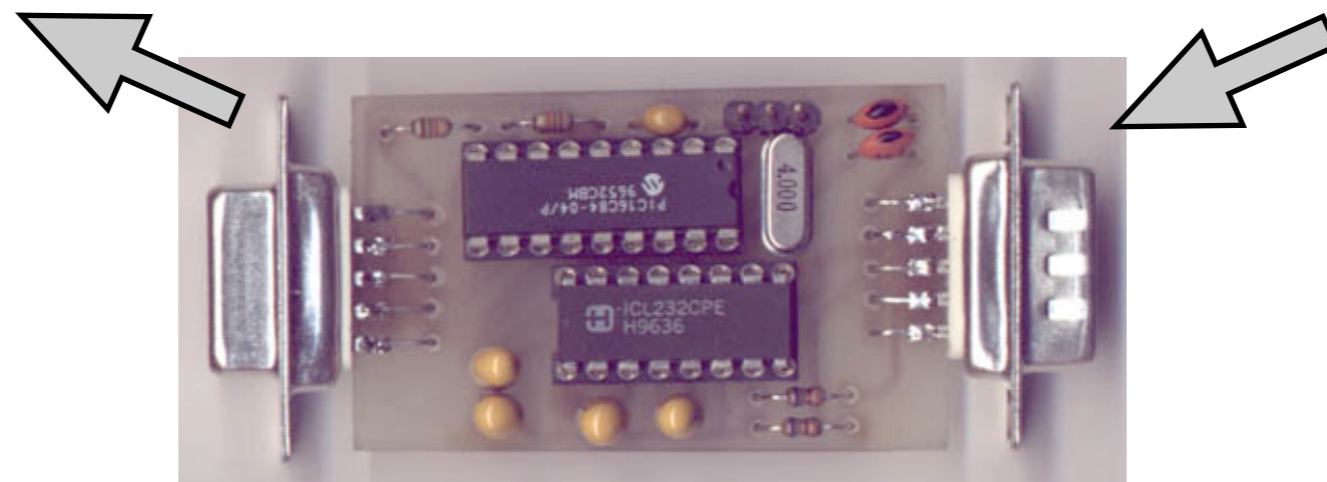
The Basic Idea



Design Blueprint



Factory

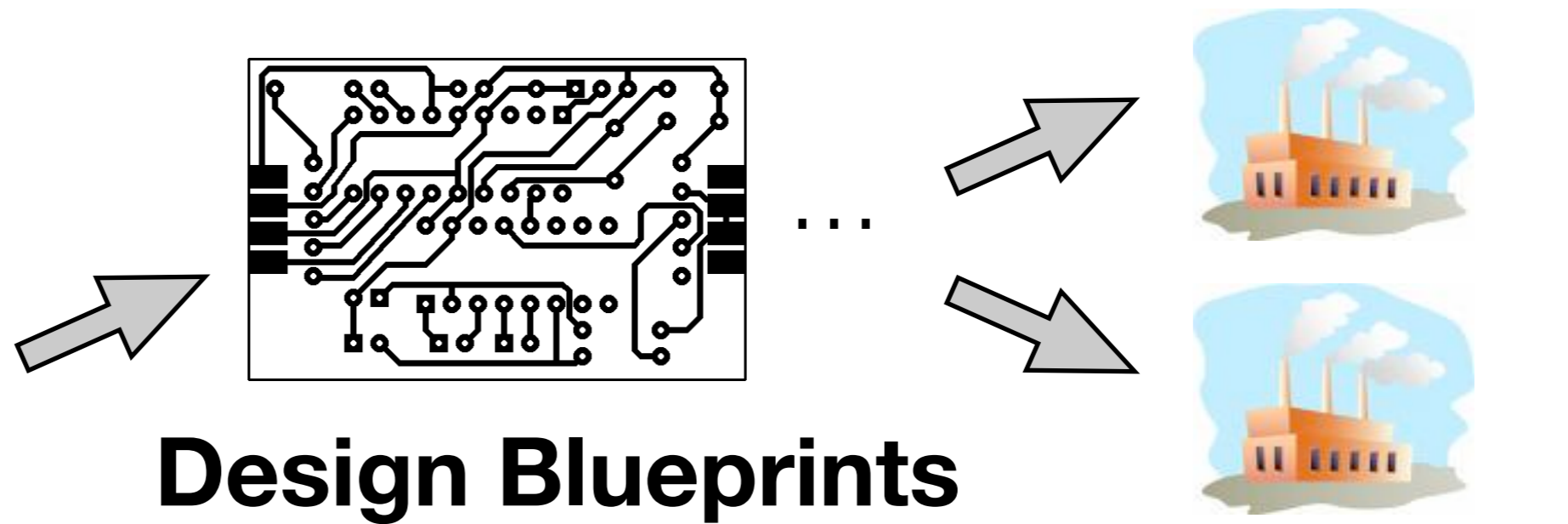


Manufactured Device

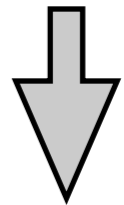


You

The Basic Idea



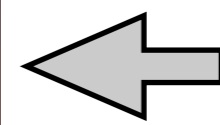
Factories



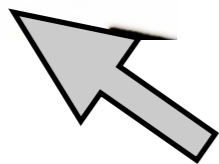
Assembly



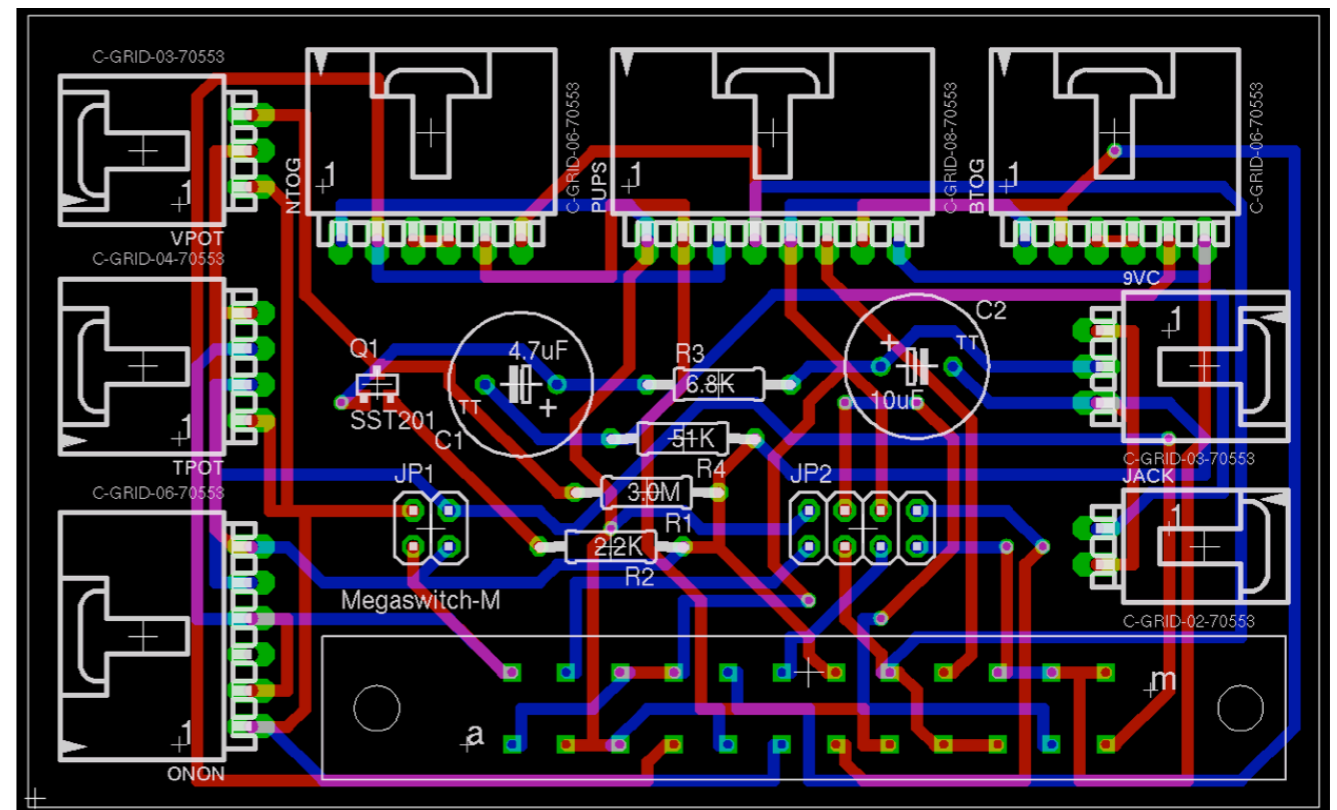
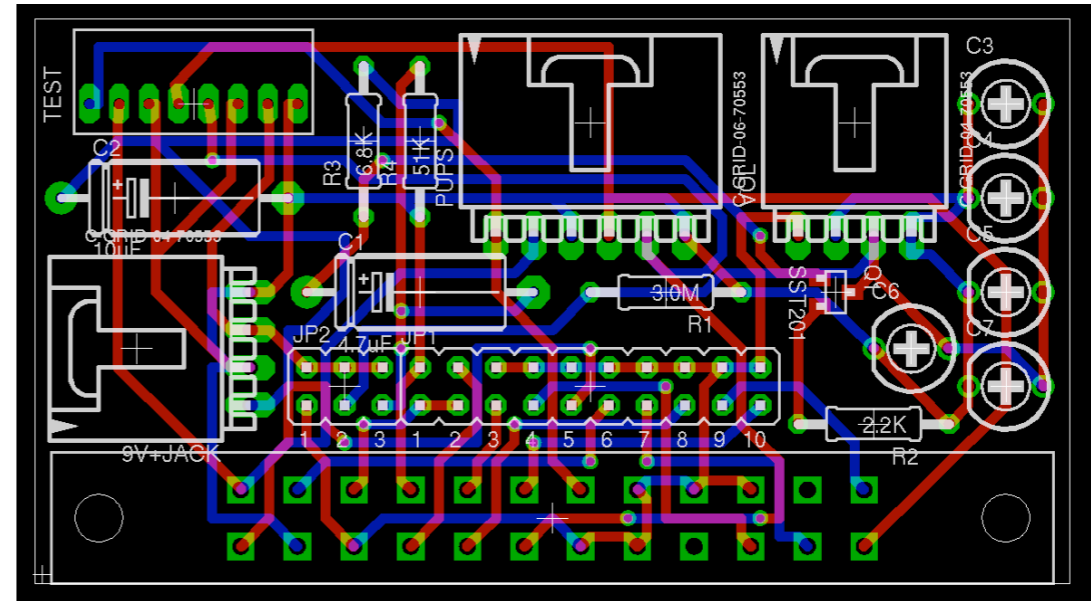
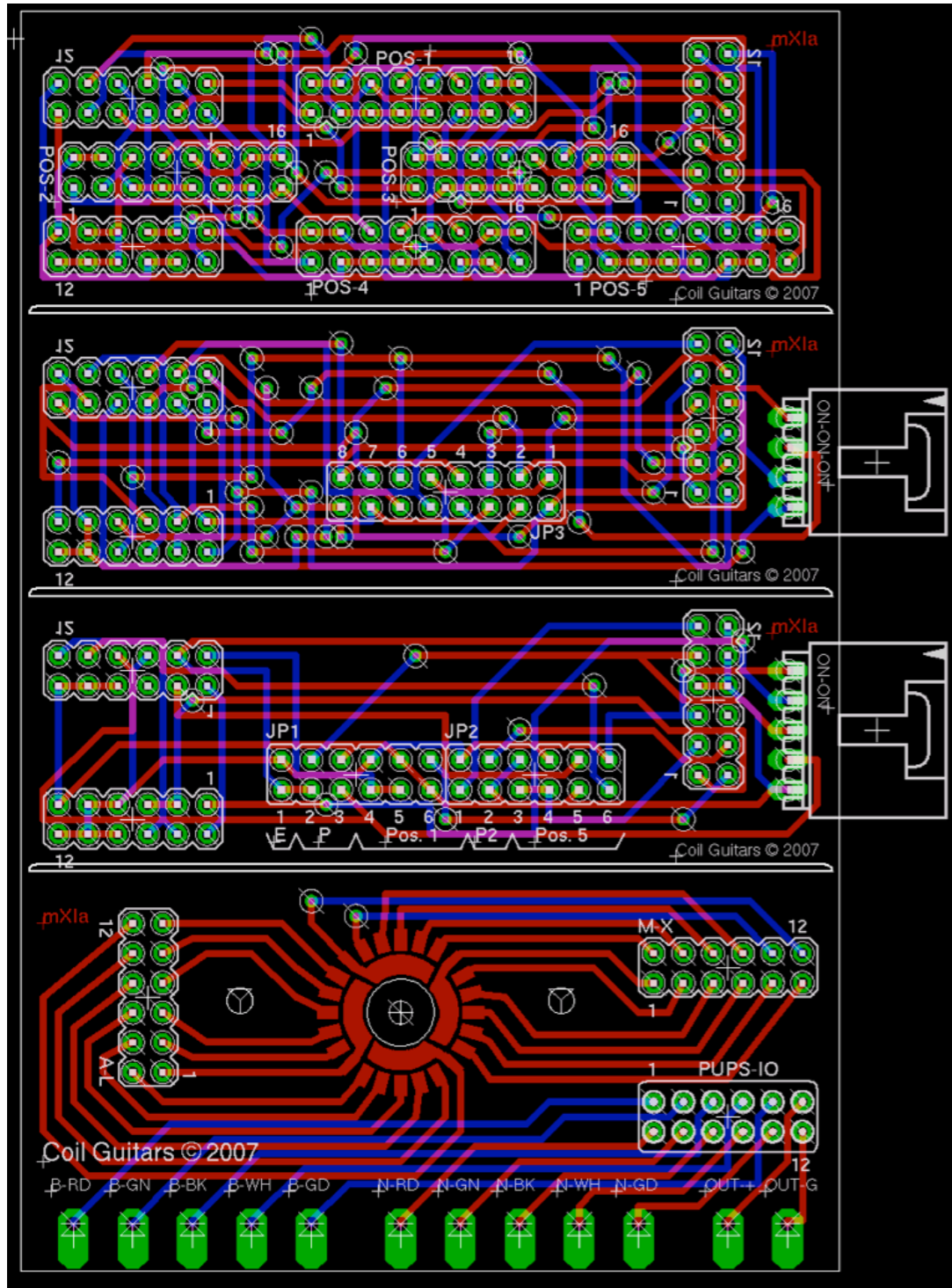
Manufactured Device



You



Some Blueprints



Pros & Cons

- Can't Possibly compete with big companies
- Might fail
- Can't afford it
- Window of opportunity?
- Idea already proven in marketplace (shareware, boutique electronics)
- Win/win situation (even company failure is good résumé material)
- Low risk/reward ratio
- Start soon

Bottom line: a path well worth exploring

Questions?

(thank you for your attention)

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