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December 13, 2007

On supporting a high-tech cottage industry … an open letter to the engineering-education community

Dear Colleagues,

For the past ten years, I have taught my undergraduates so that they could become good employees of companies like Intel, AMD, Motorola, Cisco, Google, and so forth. This is in support of the normal progression in the student life cycle: they arrive relatively green; we inundate them with tools and techniques and try our best to infuse them with an appreciation for our larger discipline and a curiosity for learning; they ultimately leave to work for companies both big and small (and one can include as examples of "big companies" both universities and the government).

I have read much in the last year that has changed my mind about my role in this process. Most importantly, I believe that now is an ideal time for students and fresh graduates to start up medium- and high-tech companies on their own, and we as educators should not only foster and encourage this but should illustrate to our students that it is both realistic and extremely advantageous. My reasoning:

1. The popularity of the net has resulted in numerous manufacturing plants creating web presences, and many of these plants offer retail custom construction. For instance, circuit-board manufacturers accept Gerber files uploaded via the web; some will also do assembly—i.e., given bills of materials they will return a fabbed and completely populated board including all parts soldered to the board as specified and will purchase the parts directly from distributors for large enough quantities. Similar services are available for CNC routing, plastics, metal working, etc. The implication is that one can start a "manufacturing" company that has all its manufacturing done by third parties. Think intellectual property and design, but apply it beyond soft cores to hard objects: mp3 players, wall clocks, calculators, home-area networking devices, whatever one can dream up. The focus is on design: anything you can design, someone out there can and will manufacture for you, and the net has simplified tremendously the search for willing manufacturers.

2. The modern consumer has demonstrated that he/she is willing to pay for convenience: witness the popularity of Amazon, eBay, Yahoo Stores, and the myriad shopfronts on-line. Consumers routinely purchase things they have never seen in person, and they do not think twice about paying for shipping. The implication is simple: if you have something of value, people all around the world are willing to buy it from you.

3. The question raised by the previous point is *why would they buy it from me instead of [big, established company X]?* Addressing this are several examples that suggest the modern American

consumer finally appreciates a shortening of the producer–consumer chain, the degree of removal between the guy who makes/grows the thing and the guy who uses/eats it.

a. First, the shareware industry—this is a healthy industry filled with people who either supplement their existing income with or live entirely off sales of their home-grown software. Consumers evidently see a tangible benefit in being one email away from the guy who wrote their software, as opposed to buying a shrink-wrapped box produced by a nameless, faceless sea of cubicles.

b. Second, the recent move towards community-supported agriculture—the decision of many people to favor purchasing foods grown locally, including fruits & vegetables, dairy, meats, nearly all foods imaginable. Seeing the conditions in which the food is produced is a tangible benefit that many consumers desire—enough to shrug off the convenience offered by the supermarket and shrink-wrapped styrofoam cartons produced far away.

c. Last, there is even evidence within the electronics industry of consumers choosing small producers over large manufacturers. High-end audio systems are often hand-made in small shops or by individuals, and this includes everything from amplifiers that sell for tens of thousands of dollars to "boutique" stomp-boxes that are used by musicians to distort the sound of their instruments in unique ways and that sell for hundreds of dollars (compare to tens of dollars for equivalent versions from large manufacturers).

These examples obviously represent small numbers of consumers in a relative sense: it is most certainly not the case that most people prefer shareware, CSAs, and/or boutique stomp-boxes. However, though the relative numbers are small, the absolute numbers are significant and seem (to me, at least) to be growing. Many consumers see value in having a closer connection to the producer of their goods; they understand that the smaller producer cannot afford to sell products at the same low price points as the larger, higher-volume producers; and they see enough of a benefit that they pay more for the personal touch, uniqueness, or hand-made quality. The implication is that the modern market is receptive to cottage industries: people making and selling stuff out of their home or small office.

4. Considering the above points, the cost of starting up a design company is about $1000 (for a laptop and a net connection). Compare this with the cost of creating a manufacturing plant, and it is easy to understand why large companies think about product design in terms of millions of units: it is not worth their while to design a product that will sell less than X millions of units, because anything less than that will fail to pay for itself. By contrast, a small company comprised of 1–3 designers need only sell enough units to net reasonable incomes for those designers. A viable business can be run on low to medium six-figure gross sales, something no large manufacturer could even consider. The implication is that it is worthwhile to explore unusual, unique, risky designs that appeal strongly to a small segment of the population, because those markets will be avoided by large companies, and yet only small numbers are needed to sustain a cottage-design venture.

5. The time to try such a venture is while still a student or right after graduation, when the cost of failure is effectively nil. There is no downside, really: success is clearly a good outcome, as a student could potentially support him/herself indefinitely by doing good design work. But the failure to produce a self-sustaining venture is also (at least potentially) a "good" outcome, because the lessons learned in the attempt are generally considered extremely valuable by corporate employers.

A recent graduate who went through the steps to design, produce, quality-test, certify, and market an interesting tech item (which ultimately failed to sell) will most certainly be more appealing in an interview than a recent grad who never built a thing. In many instances in life, even failure is a type of success, and I believe this is such an instance.

When parents come to the University of Maryland with their high-school-aged sons and daughters to get a feel for our campus, the primary concerns on their minds are the outsourcing of engineering jobs and the employment prospects upon graduation. These topics are closely related. One thing history has shown clearly is that good design is never outsourced: it is valued above all else, and those displaying it as a skill are not considered simply "warm bodies." One of the best ways to learn good design is to do it, by taking responsibility for an entire product from start to finish. This type of dedicated focus does not combine well with the typical academic experience, because it requires one to work on a single thing to the exclusion of all else, 16 hours a day, 7 days a week, for a good 6–12 months[1]. Try that in college, and you'll most certainly fail out. Come to think of it, this may explain why so many successful entrepreneurs were college drop-outs.

At any rate, the bottom line is that today's economy is supportive of a high-tech cottage industry: numerous small start-up ventures that have the initial goal not of getting rich quick but rather supporting a very small number of free-lance designers indefinitely at reasonably comfortable salaries. This is technically realistic; it is financially realistic; and, if the students involved are motivated and disciplined, both outcomes are worthwhile. So, if we wish to foster such a scenario, what do we as educators need to do?

1. Teach good design principles & techniques. Sadly, there are few texts that cover this, since most of the people who know good design principles are in industry, where it is typically learned by doing. Universities currently offer numerous courses, seminars, and workshops on entrepreneurship and tech start-ups, but these forums invariably focus on the writing of business plans, attracting venture capital, developing management and marketing plans, and other examples of putting the cart way before the horse. Good design is infinitely more valuable than money.

2. Make students aware of the possibilities. Students do not suffer from a lack of creativity, but they do suffer from an understandable lack of perspective: they are more than willing to go explore a room, they need only to be told the door exists. The reason that they are narrowly focused when searching for jobs is usually because they are unaware of the alternatives.

3. Teach the fundamentals well. It is likely that good design will be learned outside the classroom, despite our best efforts; thus, it is critical we ensure that students go forth well prepared, enabled to discover it for themselves. Ground them in the best tools and techniques, and be sure to relate these to other tools and techniques so they appreciate the difference. You may not be able to teach a student to fly, but you can surely teach him what a wing is and how it works.

Students—most people, actually—are only aware of two primary career paths: one in which you earn a modest to comfortable salary at an established company, and another in which you start up a company that either goes bankrupt or hits it big. However, there is a third alternative: starting a company that

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[1] An interesting side-note is that this type of long-term exclusionary focus is *exactly* what is required to get a research degree (e.g., the Ph.D.). So, in one sense, within academia we are already teaching/fostering/enabling the focus that is required for good design—we are simply doing it at the graduate level and in the context of research, rather than at the undergraduate level in the context of product design.

produces a comfortable salary. So much raw manufacturing capability is exposed at the retail level today that an individual now has the ability to produce items previously only within the reach of firms that had invested tremendous amounts of capital. This is an opportunity that students need to know about, as it offers a unique career path in terms of creativity and freedom of design.

I have to wrap this up with a wonderful quote from Paul Graham (Hackers & Painters, O'Reilly Media, 2004), one of the creators of the software that powers Yahoo Stores:

> If you want to make money at some point, remember this, because this is one of the reasons startups win. Big companies want to decrease the standard deviation of design outcomes because they want to avoid disasters. But when you damp oscillations, you lose the high points as well as the low. This is not a problem for big companies, because they don't win by making great products. Big companies win by sucking less than other big companies.

I love that quote.

If you are passionate about building something new, cool, unusual, and risky, you need not ask anyone's permission: the tools are there for you to do it yourself, costs are surprisingly low, and there is every indication that you can successfully support yourself at it. At no other time in human history has it been so easy to reach so many people with one's design. The chain from producer to consumer is now, at least potentially, the shortest it has ever been in history, if the number of potential consumers is factored in to the equation. It is now a time to focus on building things of value—good designs that improve the lives of people—because it has never been easier to get them into people's hands. Moreover, we as educators can and should get this message into the heads of tomorrow's designers.

Thank you for your indulgence.

Sincerely,

Bruce Jacob
Keystone Professor and Director of Computer Engineering