Great UI Can Promote the "Do Everything Ourselves" Economy

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Abstract. As user experience designers know, great UI design isn't just a frill. It isn't just about aesthetics, and isn't just about efficiency or convenience. But what designers might not yet appreciate, is that great UI might actually hold the key to solving some of the major social problems of our time – like poverty, inequality, war, and climate change.

It might do so through an unusual route – enabling end-users to solve problems themselves that would otherwise require interactions with large industrial organizations. Great UI is now enabling "Do it Yourself" (DIY) culture, from home repair videos, to the Maker movement enabled by 3D printers. What if we could evolve these developments into a "Do Everything Ourselves" (DEO) economy? This could form the foundation of a more sustainable, more equitable economy for the new age of Artificial Intelligence and Personal Manufacturing.

Keywords: artificial intelligence, 3D printing, user interface, user experience design, maker movement.

1 Introduction: Three ways of doing things

Many human needs can be addressed in one of three different ways: First, you could try to address a problem yourself. If you need something, you could try to make it. If you need something done, you could try to do it yourself.

Another way is to have others help you. If you are blocked on some task, have a more competent friend offer advice. Families and friends routinely help each other out in this way.

The third way is to try to get "the marketplace" to take care of it. You could find a store that sells the thing you want. A professional you hire could offer a service you need. It just costs you money.

All three methods may work, and we all make use of each of them under different circumstances. But they each have their pros and cons.

Doing it yourself (DIY) has a bunch of advantages. You can customize the object or get the task done exactly the way you like it. You can work on it whenever or wherever you like. It can save you a lot of money, as your own labor is "free", and you may just have to spend for materials. The downside is that you are limited to what you have the time, expertise, tools and raw materials to actually do yourself.

Enlisting family and friends to help you also has advantages. Now, you are not just limited to what you can do yourself, but the time and expertise of others. Both giving and receiving help can strengthen your relationship with people you care about. But the downside may be that their time and expertise (and perhaps willingness) is also limited.

The third option, the marketplace, results in a vastly expanded range of what you can do. People can specialize in making particular things or offering particular kinds of services. They can spend time improving their skills and become better at performing tasks. They can offer their expertise to anyone with the money to pay for it.

But there's the rub. Specialization of products and labor require money as a medium of exchange. Then, you need markets, stores, shopping, banks, factories, jobs, bosses, commuting, advertising, W2 forms, etc. etc. Welcome to 21st century Capitalism.

It's worked well for many people (but not everybody) for a long time. But Capitalism is already fraying around the edges, and there are serious questions about whether it is sustainable as an economic system in the long term.

One thing we'll observe is that the tradeoff between these ways of doing things depends on the state of technology at any given era. In the agricultural age, households had to be more or less self-sufficient. Growing your own food, building your own houses, and making your own clothes or other possessions, was the norm. There wasn't the option of the marketplace.

Now, most personal needs in first-world societies are taken care of by the marketplace. But in enabling the marketplace with industrial technology, somewhere along the way, we lost the DIY option. Products are now too complex for individual production; supply chains are too long; services too specialized. And individuals have to bargain to obtain them, earning money and spending wisely. They're competing with the very same marketplace that is supposed to be meeting their needs. And it's a competition that's far from fair.

But now we're entering a new era. Robots are automating production. AI is automating services. The network is facilitating sharing of expertise and building community. Individuals and small groups, armed with advanced technology, can now perform tasks that were once the province of professionals and big companies, through *disintermediation*. "Economies of scale" is not an iron clad business rule, it depends on tech. The new technologies may change the tradeoff between specialization of labor, and DIY.

Might it be possible to get the advantages of both? Can we get the customization , personalization and low cost of DIY, but be able to handle the range of products and services enabled by the collective wisdom of humanity? We think so.

But we're not quite there yet. The key to achieving this goal may well be in design of better user experience for tools and tutorials, including the tools and tutorials that help make tools and tutorials.

2 It's Now Amateur Hour

One effect of the popularization of digital technology is that it enables amateurs to perform tasks that were previously the domain of specialized experts. There are, for example, a wide range of home repair tasks that might lead many homeowners to hire a plumber or electrician. But a plethora of online videos and instructional materials now make it feasible for relatively unskilled homeowners (like your authors) to attempt the task themselves, even if they are not so-called "handymen" (amateur home improvement enthusiasts).

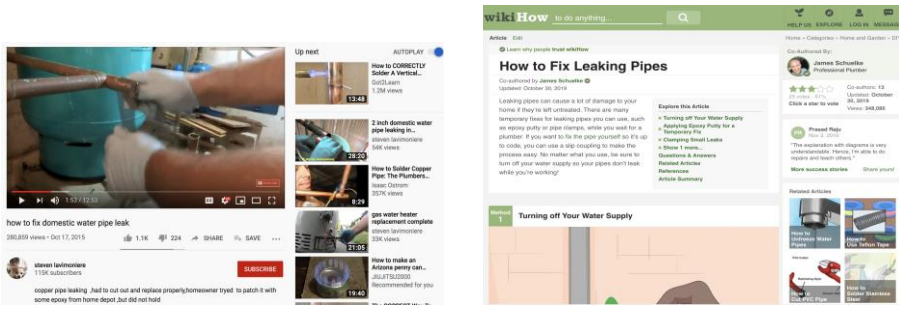

Fig. 1. Online tutorials from YouTube and WikiHow.

Graphic designers and user interface designers have experienced similar transformation to the handyman in their profession. It was once absolutely necessary to hire a professional graphic designer if one were preparing a publication-quality book, poster, or ad. Now, these (or their online versions) can be prepared by relatively unskilled authors using graphic editors and layout programs, if the task is not too complicated or demanding. In some professions, this caused a crisis, as professionals feared they would be put out of work. Indeed, there were many instances in which they lost business they otherwise might have gotten.

But plumbers and graphic designers have not disappeared. While routine tasks may now be handled by the customers themselves, professionals are still needed to handle more complicated tasks (or to clean up the disastrous mess left by an amateur who failed). Graphic designers can now focus on aesthetic decisions instead of the mechanics of printing processes.

Professionals seem to have made peace with the influx of amateurs. Now, many of the tutorials are authored and promoted by the professionals themselves. They educate potential customers about the subtleties of the task they are about to undertake, and build confidence in the DIY'ers competence. It can also be good for business of the pro. If you are indeed in need of a graphic designer, why not choose the one who helped you learn about the graphic program you're now using?

The process of better user interfaces replacing professionals has a long history. Telephone operators, gas station attendants and travel agents have all succumbed to do-it-yourself user interfaces. As the user interface to authoring tools and the how-to guides

themselves improve, the breadth of activities they encompass can expand because domain experts who aren't programmers will be able to produce great UI experiences.

2.1 With a Little Help from My Friends

An intermediate scenario between doing this totally by yourself, or handing it off completely to a professional, is a *cooperative* approach. You can attempt a task by yourself, but then, if you run into trouble or need expertise beyond your current capability, you can reach out to others to collaborate with you on the solution.

This can take the form of a *panic button* on the DIY interface, that calls a helper. The helper can be a member of your friends or family circles, or a professional. Through *telepresence*, the helper can help as if he or she were in the room with you.

We need better interfaces for collaborative and remote problem solving. It's not just a matter of transmitting video and audio. The panic button could send the helper a history of the DIY'ers previous attempts to solve the problem and the current state of the work objects. It could bring up documentation, plans, schematics, costs, etc. in a just-in-time manner.

It's already starting to happen that professional services are marketed and/or delivered over the net. For some, it can replace onsite work, and its overhead, entirely. Our conventional plumber has to:

- Get and maintain a plumber's license.
- Drive to work and back.
- Drive to each work site and back
- Have a receptionist for scheduling jobs
- Have an accountant for billing, taxes, payroll and managing a bank account.
- Order, inventory and stock the truck daily with the right parts for a job.
- Find the customers (via advertising or other means)
  in addition to performing the actual work.

Many of these steps can be eliminated by online interfaces. The plumber doesn't have to hire an electrician, or a contractor, an accountant, etc., because all of those services have similar DIY interfaces.

3 Why don't more people DIY?

To do a given task, you need:

- Know how
- Parts and/or raw materials
- Tools
- Time

and, most people, for numerous tasks they want to accomplish, are lacking in one or more of these needs. If we can supply these needs, more people could DIY for a much

wider range of tasks. Internet resources, like the videos above and special-interest social media communities, can provide the know-how. What about the other requirements?

Parts and tools can be problematic. Many modern devices require specialized parts and tools that only professionals have. But help is on the way.

We'll need rather advanced "printers" that cannot just perform additive manufacturing, but subtractive, casting, origami, and pick and place. We call such tools *personal factories*. We'll need some specialized machines, such as contained aeroponic boxes for growing food efficiently without pesticides or weeds. Such specialized tools can be produced in a personal factory.

Once a 3D printer has enough capability to print out all the parts for another 3D printer, then they will be "reproducible" by DiY'ers and their effective cost will drop to the point where they will be accessible to all.

Going forward, we can try to rethink the design of products and services to put a priority on accessibility of parts and tools. We can prioritize using readily-available materials instead of special-purpose exotic substances. We can prioritize maintainability and repairability rather than planned obsolescence of products. We can end the so-called *connector conspiracy* that is constantly introducing new proprietary and incompatible interfaces, in order to trap the user into expensive additional purchases.

Finally, time. Right now, many middle-class professionals don't have the time to handle home repair, growing food or other tasks. But as the scope of DIY methodology increases, it will begin to encroach upon professional services. Perhaps to the extent that for increasing numbers of people, the value of DIY activities can increase to the extent that they will be competitive with earning a living in the marketplace. More on that shortly.

As we learn more about psychology, both cognitive and perceptual, we have new theoretical tools to enhance learning/know-how. As our communications and information presentation technologies improve, we will have new ways to deliver our advances in learning psychology. As our manufacturing technologies improve, we will have new ways to deliver hardware. If we are strategic, these techniques can save human labor, the greatest cost of pretty much anything.

4 Augmented Reality Brings Expertise to the Masses

Here's a future scenario:

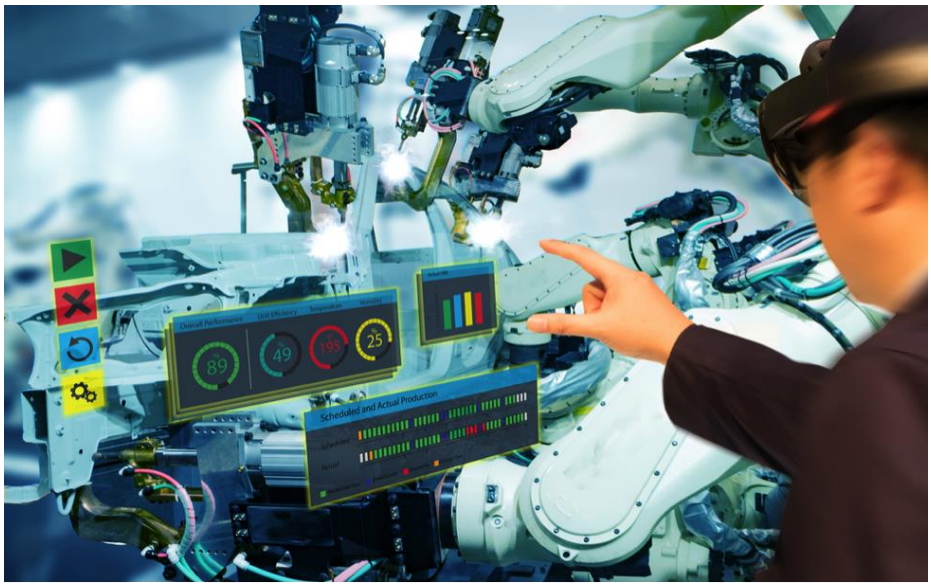

Fig. 2. An augmented reality interface for mechanical repair.

You're wearing corrective eyeglasses as usual, but these are fitted with a programmable transparent Augmented Reality (AR) display and a couple cameras to let a computer (or a remote person) see what you're seeing. We also have mics and earphones for audio I/O including speech synthesis and recognition. This is nothing that hasn't been imagined millions of times before now [1], and implemented to a weak degree.

The computer connected to this I/O has a model of your house. Every house design should be preserved for the actual occupants of the house to take advantage of, instead of disappearing in the architect's trash can.

A water pipe in your house springs a leak. You look at the water.

You: "Looks like a water leak." Your computer examines its 3D database of your house, sees "behind the wall" and notices a copper pipe with a straight connection fitting at that location.

Computer: "Shut off the water to the house in the basement." You go to the basement. A big green arrow in virtual space points at the valve, with a circular arrow telling you which direction to turn it in (clockwise).

Computer: "You'll need a crowbar, a wrench and a new washer. You have the tools in your basement. You have the raw materials to print the washer. Printing will take 4 minutes. Shall I begin?"

You: "Yes". The computer knows about your 3D printer and what materials you have available.

A few minutes later. *Computer*: "The washer print is done." You go to your basement. The washer is outlined in green in your AR glasses. You pick the washer off of the printer. Looking at your tool shelf, the crowbar and adjustable wrench are outlined in green.

Computer: "Open up the wall with the crowbar. Example video *here*. You touch the virtual *here* with your real hand and watch the 2 minute video. You open the wall and replace the washer. *Computer*: "Are you ready to patch the wall?" ...

Our AR headset delivers the know-how. Our connected 3D printer makes parts for us, and can even make tools if we lack them. Even with such hi-tech we're not forecasting the manufacture of "time" (sorry). But if you had to find a plumber, schedule a time, wait for him to show up, be there while he's working and work for the money to pay him, perhaps the AR system we describe *does* save you time, even if you're several times slower on the actual task than a pro would be.

We need authoring tools to create the Augmented Reality how-to guides. These are similar to Software Development tools or authoring software. Difficult to make easy, but doable, especially with the collaboration of UI experts. They too will give away their expertise, if UI design is their passion and they have a personal factory to make what they themselves need.

First, one of the strongest motivations of people is to have an audience. Authoring a Great UI tutorial is a way to get an audience. Now for the real-time use of an expert for a specific situation, we'd have to have experts sign up for time slots and be "on call". An expert would do it just because most people actually like to help others. Those that don't, won't sign up to be on call. But we're guessing many will. We can give such helpful pros merit badges on top of the appreciation their "students" will show.

Medical pros now agree to the Hippocratic oath: "I will respect the hard-won scientific gains of those physicians in whose steps I walk, and gladly share such knowledge as is mine with those who are to follow". If a doctor doesn't have to go to the office, fill out insurance forms, or catch colds from their patients, we expect many will continue to fulfill their Hippocratic oath in a world of Great UI and sign up to be "on call" at least a few hours a week.

Finally, we need people to actually use the authoring tools to make great directions. As above, people love to give away their expertise. Make the tools easy to learn and they will be used for car repair, house building, food growing, health-care products, clothes making, augmented reality headset fabrication, computer maintenance, and whatever else people commonly need.

5 From “Do it Yourself” to “Do Everything Ourselves”

Imagine if *everyone* could become a DIYer. Would that make, overall, a more efficient economy? The conventional answer is: *No*. Specialization of labor means expertise can be concentrated and leveraged to great effect. You don't need to be an expert to get a job done, you just need to hire someone who is. However, new technologies can change that equation.

Does this mean you trade in your 40 hour work week at a “job” for a 40 hour work week at home fixing leaks and weeding your garden? Perhaps. But with advanced robotics, the repetitive tasks can be automated. Such capable robots are now expensive, but we've got this great UI to help us print the parts and the tools, plus deliver the know-how to put together our robot.

5.1 Makerism: The Antidote to Capitalism

We call this economy, where everyone is a do-it-yourselfer, *Makerism* []. Experts and remote factories aren't necessary for making and fixing most of the things you need done because you can follow excellent directions (not today's "some assembly required" nightmares.)

Compare our conventional economy to this new Makerism economy facilitated by great UI. Which one would take the least amount of labor to produce a comfortable lifestyle for all? First, its rather improbable that Capitalism could produce a comfortable lifestyle for all since it depends on inequality. But pretend some tweaks to Capitalism could, unlikely though that now appears

In Makerism, none of that is necessary. Yes our inexperienced home-owner will take longer than a pro to make a repair. But the overhead of our conventional economy is high. Just think of the lifecycle of a part in today's economy. Parts have to be redesigned for each competing company due to intellectual property laws and trade secrets. In Makerism, designers give away their design just like most of the rest of the content of the web. Design once, use by anyone. (Designers, like other Personal Factory owners, won't need a salary.) Thingiverse.com now contains more than a million designs for 3D printed parts, all freely downloadable. Facilitating the search for the best part is another opportunity for great UI!

Once our part is manufactured in a conventional factory, it has to be packaged, warehoused, transported to a store, retailed, marketed, money has to change hands (that alone is several percent!). Then it has to get from the store to your house. All of *that* is unnecessary under Makerism too. With great UI, we believe total labor for fulfilling humans' basic needs will decrease.

5.2 Can We Sustain the Status Quo?

No. Trends like climate change are accelerating, so one way or another, the status quo will change. Can we sustain Capitalism? Capitalism drives companies to maximize profit. The easiest way to do that is to cut costs (and perhaps ignore possible environmental consequences). The largest cost for production of physical objects, is labor. This is why automation is increasing. With smarter AI and more dexterous robots, it seems unlikely that humans can compete. We don't need AI and robots to be as good as humans, just good enough at the rather constrained tasks at most jobs to be cheaper than a human's salary to displace human workers. Without paychecks, people can't buy what the automated factories are making. Ergo, Capitalism itself is unsustainable.

Most economists disagree with this prediction. But most economists are not technologists. Yes, in the past, retraining for new jobs has allowed humans to compete with machines. The new jobs have come largely from replacing manual work with knowledge work. But when knowledge work starts getting automated, the generation of new jobs to replace technological unemployment, may come to a close. Sure, there will be esoteric services that only a human can provide. But once your basic needs are met with a personal factory, how many people will want to trade their time for such esoteric services?

Imagine we're wrong. Would most people rather work at a normal job, or stay home, fix leaks and tend a garden? With advanced tools, we believe the later will take less time than a normal job, and give a person more control over their remaining time. They may join organizations whose mission statements they revere (no salary required). They may join a band, write a book, teach (or attend) course

But it's not just a question of which economic strategy is more efficient, specialized labor economics vs DIY. Can we sustain today's specialized labor/"free" markets? A number of trends indicate that we might not be able to. Inequality is increasing, and Capitalism does not seem to have functioning mechanisms for relieving inequality. DIY becomes not just an alternative, but perhaps the only plausible means to accomplish the broadly shared goals of individuals.

6 Education

Having "Great UI" enabling a person to complete a task is a form of "Just in Time Education". There's no need to learn or remember the task prior to performing it. There's not much utility in remembering how you did it either, because you can reuse the just-in-time tutorial should you need it again. "Just in Time Education" is ideally suited to emergencies and rare tasks where repeats are unlikely. If its an often repeated task, you learn first from the "Great UI", then you can just do it on your own.

Useful though this may be for how-to scenarios, it doesn't foster the deep understanding of processes needed to adapt them to new situations or to invent whole new processes for novel circumstances. None-the-less, when a series of just-in-time tutorials is appropriately spaced, they can promote "learning by example". By making a second tutorial different enough from the first to contain new techniques, yet similar enough to demonstrate an analogy with the first tutorial, a student may gain some ability to generalize. By stringing together an orchestrated sequence of such well-spaced tutorials, deeper understanding of processes are possible, particularly if the sequence comes "full circle", tying together the first and last of the tutorials.

6.1 Programming by Example

A clever way of reducing the need for programming skills to create an application is called "programming by example" [3]. This involves the programmer showing the computer an example of what to do, The computer records the task and can repeat it later. With a more clever development environment, the programmer can show the computer a number of examples, and the computer can take note of both similarities and differences between the examples. These can be used to generalized the automatically generated algorithm for applicability to other contexts.

We can use this programming by example technique in reverse whereby the *computer* is showing the *human* examples, so that the human can learn and generalize from them. This is sometimes called *active learning.*

7 A Call to Arms: UX Design for Economic Independence and Peer Collaboration

Think about how User Experience design would change if it adopted the agenda we outline here. The constant, of course, would be that user interface designers are, as always, concerned with providing the best possible experience for the end user.

But most user experience design today is done primarily within the context of companies who are selling physical objects or software, promoting user engagement with web sites to attract attention to advertising, or in support of professional services delivered through the marketplace. These objectives may cause a conflict of interest with the primary goal of acting on behalf of the user. Social media, for example, has the positive purpose of connecting family and friends, but interfaces are also designed to deliver user attention to annoying advertising, and to encourage addiction. In the long run, the goal of serving two masters is not sustainable.

In the world we're envisioning, the purpose of user experience is to empower the end users to be more economically independent. It is to help the users solve problems and undertake positive activities in their life, by helping with them with the expertise they need. Rather than software which simply accrues "features", software should include step-by-step tutorials that teach users what they need to know; help them debug situations when things go wrong; and include general-purpose programming languages that allow users to customize or invent solutions to novel problems. It should be seamlessly integrated into their physical, social, and computational environments.

We also need better software for collaboration. Most software now is designed either to be operated by a single individual, or to deliver a commercial product or service that a user is paying for. We need software that better enables users, both amateur, enthusiast, and professional, to collaborate on problem solving. We need software that helps small groups of users collectively make informed decisions and embark on courses of action that satisfy their interests.

The "do it yourself"er takes joy and pride in their ability to meet their own needs and the needs of people they care about. Why not bring that joy and pride to everything?

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