The Rise of the Expert Amateur
DIY Culture and the Evolution of Computer Science

eric paulos
bcnm • eecs • uc berkeley
8-bit microcontroller
no realtime clock
no threading support
no floating point
debugging through printf
all through hole parts
socketed processor
misalign header pins
Microchip PIC
Microchip PIC
Microchip PIC
BASIC Micro’s Basic ATOM
Interval Research Corporation

Gillian Crampton-Smith, educator and interaction designer
Franklin C. Crow, inventor of important anti-aliasing techniques
Marc Davis, founder of Yahoo! Research Berkeley
Paul Debevec, computer graphics researcher
Glenn Edens, founder of Grid Systems, which made the first laptop computer
Rolf Faste, Stanford design professor
Lee Felsenstein, designer of the first mass-produced portable computer
Don Hopkins, new-media artist, The Sims developer and pie menu interface designer
Bill Verplank, interface designer of the Xerox Star, the first WIMP (computing) GUI
Brenda Laurel, author, entrepreneur, virtual-reality artist
Golan Levin, new-media artist
Michael Naimark, new-media artist
David P. Reed, inventor of TCP/IP
Richard Shoup, creator of SuperPaint
Malcolm Slaney, electrical engineer, and creator of the first sound toolkit for Apple Computer
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```java
/**
 * Brownian motion.
 *
 * Recording random movement as a continuous line.
 */

int num = 2000;
int range = 6;

float[] ax = new float[num];
float[] ay = new float[num];

void setup()
{
    size(200, 200);
    for(int i = 0; i < num; i++) {
        ax[i] = width/2;
        ay[i] = height/2;
    }
    frameRate(30);
}

void draw()
{
}
```
-- JAL 2.3
include 16f877_bert--define the variables
var byte resist--define the pins
pin_a0_direction = input--variable resistor
pin_d7_direction = input--switch
pin_c2_direction = output--pwm led--enable pulse width modulation
PWM_init_frequency (true, true)

forever loop--convert analog on a0 to digital
resist = ADC_read_low_res(0)

-- run measurement through flash memory
program_eeprom_write(2000,resist)
program_eeprom_read(2000,resist)

-- run measurement through data memory
data_eeprom_write(10,resist)
data_eeprom_read(10,resist)

-- if the switch is pressed return random value
if pin_d7 == high then
  resist = random_byte
end if--send resistance to PC
serial_sw_write(resist)
delay_100ms(1)
-- set actual PWM duty cycle
PWM_Set_DutyCycle (resist, resist)

end loop

Programma 2003
```c
int ledPin = WLED; // a name for the on-board LED

void setup () {
    pinMode(ledPin, OUTPUT); // set pin 48 for digital output
}

void loop () {
    digitalWrite(ledPin, HIGH); // turn on the LED
    delay (1000); // wait one second (1000 milliseconds)
    digitalWrite(ledPin, LOW); // turn off the LED
    delay (1000); // wait one second
}
```

Hernando Barragán

Wiring, 2003
Why there was a need for Arduino
The First Arduino, 2005
/*@
* Blink
*
* The basic Arduino example. Turns on an LED on for one second,
* then off for one second, and so on... We use pin 13 because,
* depending on your Arduino board, it has either a built-in LED
* or a built-in resistor so that you need only an LED.
* http://www.arduino.cc/en/Tutorial/Blink
*
* int ledPin = 13; // LED connected to digital pin 13
* void setup() // run once, when the sketch starts
* {
*   pinMode(ledPin, OUTPUT); // sets the digital pin as output
* }
* void loop() // run over and over again
* {
*   digitalWrite(ledPin, HIGH); // sets the LED on
*   delay(1000); // waits for a second
*   digitalWrite(ledPin, LOW); // sets the LED off
*   delay(1000); // waits for a second
* }
*/

Done compiling.

Binary sketch size: 1098 bytes (of a 14336 byte maximum)
Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16”), not an even multiple of the 100 mil spacing of the other pins.
// The setup() method runs once, when the sketch starts

void setup() {
  // initialize the digital pin as an output:
  pinMode(ledPin, OUTPUT);
}

// the loop() method runs over and over again,
// as long as the Arduino has power

void loop() {
  digitalWrite(ledPin, HIGH);  // set the LED on
  delay(1000);  // wait for a second
  digitalWrite(ledPin, LOW);  // set the LED off
  delay(1000);  // wait for a second
hardware

void setup() {
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    pinMode(ledPin, OUTPUT);
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    digitalWrite(ledPin, HIGH);  // set the LED on
    delay(1000);                  // wait for a second
    digitalWrite(ledPin, LOW);   // set the LED off
    delay(1000);                  // wait for a second
}

Arduino Playground

Welcome to the Arduino Playground, a wiki where all the users of Arduino can contribute and benefit from their collective research.

This is the place to post and share your own code, circuit diagrams, tutorials, DIY instructions, tips and tricks, and after all the hard work, to show off your projects. Anyone can edit and add to the pages here.

Arduino Playground is a work in progress. We can use all the help you can give, so please read the Participate section and get your fingers typing!

NOUS (non-OO US) solved the problem for adding content in non-western Latin languages, now it is possible to start typing in any language on the internet text here

Playground Content Tree
hardware

software

documentation
hardware

software

documentation

hands-on learning
This circuit can be coded such that both the car and pedestrian traffic lights go through their normal cycle until the button is pressed by a pedestrian. In this case, the lights will change in favor of the pedestrian.
WearAir: Expressive T-shirts for Air Quality Sensing
Sunyoung Kim, Eric Paulos, and Mark Gross
Tangible Embedded and Embodied Interaction, 2010
ArduPilot is an inexpensive navigation-only autopilot based on the open-source Arduino platform. It is available for $24.95 at Sparkfun. The software and hardware are all open source.
Fabrication
Bre Pettis, Zach Hoeken Smith, Makerbot
Welcome to the Thingiverse.
This is a place to share digital designs that can be made into real, physical objects. Let's create a better universe, together!

Newest Things

bushing holder for
By: rbising 9 hours ago

Power distribution box
By: Worm23 19 hours ago

Bloombot
By: langfordw 20 hours ago

Featured Things

view more

view more
A collection of our favorite designs, hand-picked by the Ponoko team.

**Arduino(TM) Pro Mini Full Kit w/Enclosure**
by: TerawattIndustries  $44.00

**16X2 LCD matrix keypad kit**
by: Liudr  $14.95

**Urchin Table Lamp 8" h X 14"w - 18" base**
by: Fabripod  $200.00 - 250.00

Feeling adventurous?
Browse by tag

Like one designer?
Browse by designer

Get Showroom RSS Feed
Amateur

Latin amātor - lover

from amāre - to love
John Alexander Reina Newlands

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In almost all the varied walks of life, amateurs have more freedom to experiment and innovate. The fraction of the population who are amateurs is a good measure of the freedom of a society

Freeman Dyson
Bureaucrats sometimes do not have the correct information, while citizens and users of resources do

- Elinor Ostrom
  2009 Nobel Prize in Economics
wicked problems

Dilemmas in a General Theory of Planning, 1973
Horst Rittel and Melvin Webber

DESIGN RESEARCH
is an inquiry focused on producing a contribution of knowledge

NOT
to directly inform the development of a commercial product
wicked problems

street crime
wicked problems

street crime
disarm police?
wicked problems

street crime

disarm police?

repeal laws that define crime?
wicked problems

street crime

disarm police?

repeal laws that define crime?

substitute ethical self-control for police and courts?
wicked problems

street crime

disarm police?

repeal laws that define crime?

substitute ethical self-control for police and courts?

shoot criminals and thus reduce the numbers who commit crimes?
wicked problems

street crime
disarm police?
repeal laws that define crime?
substitute ethical self-control for police and courts?
shoot criminals and thus reduce
the numbers who commit crimes?
give away free loot to would-be-thieves
to reduce incentive?
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Design is in everything we make, but it is also between those things. It’s a mix of craft, science, storytelling, propaganda, and philosophy.

- Erik Adigard
encountering our familiar strangers

The Familiar Stranger: Anxiety, Comfort, and Play in Public Places, ACM SIGCHI 2004
Eric Paulos and Elizabeth Goodman
Vito Acconci       Following Piece        1969
PRoP: Personal Roving Presence, ACM SIGCHI, 1998
Eric Paulos and John Canny

Propeller (not visible)
Battery
Rx/Tx
Custom electronics
Camera
Mic
Speaker
Propeller

Wireless Tx/Rx
Local System
Internet
Remote Pilot

PRoP: Personal Roving Presence, ACM SIGCHI, 1998
Eric Paulos and John Canny
Aspen Movie Map
Michael Naimark
1978
Aspen Movie Map
Michael Naimark
1978

Street View
Google
2007
Michael Naimark & MIT ArchMac’s Aspen Movie Map 1978-1980

Google StreetView 2007
Legible City
Jeffrey Shaw
1988

E-fitzone exercise equipment
2008
GraffitiWriter & Streetwriter
Institute for Applied Autonomy
1998-2004

Nike Chalkbot
2009
The Telegarden
Ken Goldberg
1995

FarmVille
Zynga
2009
Graffiti Research Lab
L.A.S.E.R. Tag
2007

Graffiti by Agents of Change
all natural Cola by Red Bull
2009
Hand From Above
Chris O’Shea
2009

Times Square
Space150
2010
DaisyCam
2009

Memoto Lifelogging Camera
by Memoto

1,874 backers
$360,879 pledged of $50,000 goal
31 days to go

A tiny, automatic camera and app that gives you a searchable and shareable photographic memory.

Launch: Oct 23, 2012
Funding ends: Nov 30, 2012

See full bio

Instagram
2012
TXTMob
Institute for Applied Autonomy
2004

Twitter
2006
The clashing point of two subjects, two disciplines, two cultures, of two galaxies, ought to produce creative chances.

- C.P. Snow *The Two Cultures* (1959)
Remote Controlled Blimp
$19
Remote Controlled Blimp
$19
Remote Controlled Blimp
$19

Eric’s Thesis App
99¢
Remote Controlled Blimp
$19

Eric’s Thesis App
99¢

My PhD Dissertation
$19.99
Top
Secret
ERIC'S PLANS

Do not open UNLESS AUTHORIZED
Part 0

Top

SIDE

Put a door on each side
Piee B and B2

Engine and engine holder must be reversed for right and left side.
Flameslinger

Instructions on how to modify a spiderman webslinger into a handheld flamethrower.

Disclaimer: I haven't had any problems with this design and I have never been burned by it, however it still is dangerous and I take no responsibility for anyone who attempts to build this.
Motivations for Contributing to DIY Projects

- Express myself / be creative
- Learn New Skills
- Create things I cannot buy
- Personalize my things
- Solve problems, challenge myself
- Recycle or refurbish materials
- Showcase my skills
- Save money
- Work and spend time with my friends
- Impress other people
- Make money
- Gain internet fame or online reputation

Percentage of Respondents

- StrONGLY Agree
- Agree
- Neither agree nor disagree
- Disagree
- STRONGLY Disagree
If a major project is truly innovative, you cannot possibly know its exact cost and its exact schedule at the beginning. And if in fact you do know the exact cost and the exact schedule, chances are that the technology is obsolete.

- Joseph G. Gavin, Jr.,

discussing the design of the Grumman lunar module that landed NASA astronauts Neil Armstrong and Buzz Aldrin on the moon on July 20, 1969
Factors that Deter from Sharing with DIY Communities

- I don't have enough time
- My projects are too easy or simple
- My projects are not novel or creative
- My projects are not interesting
- I don't have the equipment to document my work
- I don't want other people to 'steal' my ideas
- I prefer to share my work through other mediums
- I don't have the skills to edit, upload and share my work
- I don't want my work to be critiqued
- My projects are too advanced or complex

Percentage of Respondents

- Strongly Agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly Disagree
• Build rather than design
• Materials must come pre-broken
• Rubbish is the root of virtuosity
• Celebrate incomplete designs
• Allow for non-rivalrous use
• Embrace new materials - organic, decomposable, Hertzian, biological, molecular, food, soil ...
RISE OF THE EXPERT AMATEUR

from proprietary innovation ...

to populist innovation
We want our technologies to sing of not just productivity but of our love of curiosity, the joy of wonderment, and the freshness of the unknown.
Innovation companies today don't ask and don't care about basic skills, grades, or SAT scores — instead, they want to know if you can brainstorm all the possible uses of bubble wrap

- Laura Seargeant Richardson, principal designer at frog design
If it were possible to define generally the mission of education, it could be said that its fundamental purpose is to ensure that all students benefit from learning in ways that allow them to participate fully in public, community, creative, and economic life.

The future of multi-disciplinary research will be through students who have been trained in multiple disciplines

- Eric Brewer
• multithreading support
• debugging tools
• deadlock detection and recovery
• low power designs
• pause, sleep, suspend, deep sleep
• parallel and multicore programming
• hyperthreads
• speculative multithreading
• dynamic processors
• asymmetric chip multi-processors
• security models with hardware for authentication
• better exception handing and scheduling model
HYBRID ASSEMBLAGES

- CPU
- Sensors / Actuators
- Radios
- Flash / RAM
- Cloud interoperability
- Physical elements and enclosure
- UI
- etc
• What is the experience of “designing”, “programming”, and “making” this assemblage?

• What skills are needed?

• Who are the right collaborators?

• Are there new CAD metaphors and design tools?
• How can such a design leverage functionality and support from existing systems?

• How can we support constraints in terms of power, cost, flexibility, interoperability?

• How can we foreground creativity into these “tools”?
expose and share your process and design materials
(perhaps instructable style)

aspire to perform with the community of makers

be promiscuous with your ideas...you’ll have others
BE AN AMATEUR