



課程介紹、Arduino與開放硬體

北藝大新媒系
授課教師：劉士達
日期：2014/9/26

講師介紹

劉士達

- 帝凱科技有限公司共同創辦人
- Arduino.TW共同創辦人
- 台北藝術大學科技藝術研究所碩士
- 聯絡方式：ken@decade.tw

課堂助教：高譽庭/lifeforce736@gmail.com



課程介紹

- 9/26 課程介紹、Arduino介紹、電子電路、LED控制開關控制
- 10/3 可變電阻、光敏電阻、蜂鳴器、水銀開關、震動開關
- 10/10 國慶日放假
- 10/17 老師請假（交第一次小作業）
- 10/24 溫度感測、距離感測、加速度感測
- 10/31 六軸感測、聲音感測、濕度感測
- 11/7 繼電器、馬達控制、Servo
- 11/14 期中考作業
- 11/21 穿戴式科技案例分析
- 超圖解Arduino互動設計入門 - 參考書(請同學們自行訂書)

課程介紹

- 11/28 無線傳輸、Arduino Mini+FTDI 232RL
- 12/5 電源配置考量與裝置設計
- 12/12 多個輸入與輸出
- 12/19 交第二次小作業
- 12/26 LED矩陣顯示、紅外線發射與接收
- 1/2 電子電路安全規範與注意事項
- 1/9 期末專題討論與問答
- 1/16 期末考

計分方式

感測器實習作業(30%) + 期中作業(30%) + 期末作業(40%)

課程介紹

感測器實習作業

1. 把題目做出來並上傳影片到youtube給助教連接彙整
2. 自己做出一個不錯的題目並上傳影片到youtube給助教連接彙整

期中作業

運用目前教的獨立訂一個題目並做出來，在課堂上報告(含電路實際操作 + 口頭說明原理，在5~10分鐘內)

期末作業

2~3人為一組的小型互動創作，需講解創作意涵與作品實際DEMO

開放硬體的全球趨勢與 互動科技

開放硬體與封閉式硬體

- 封閉式硬體設計

- 如早期的手機、電鍋、電冰箱、電扇、夾娃娃機...等等
- 廠商在設計之初就不公開電路設計方法以及程式碼，造成市場上的專利競爭
- 好處在於一間廠商承擔所有管理、銷售、研發、售後服務等責任
- 市場因封閉式硬體設計無法延伸更多創意，消費者被禁錮在特定的產品上

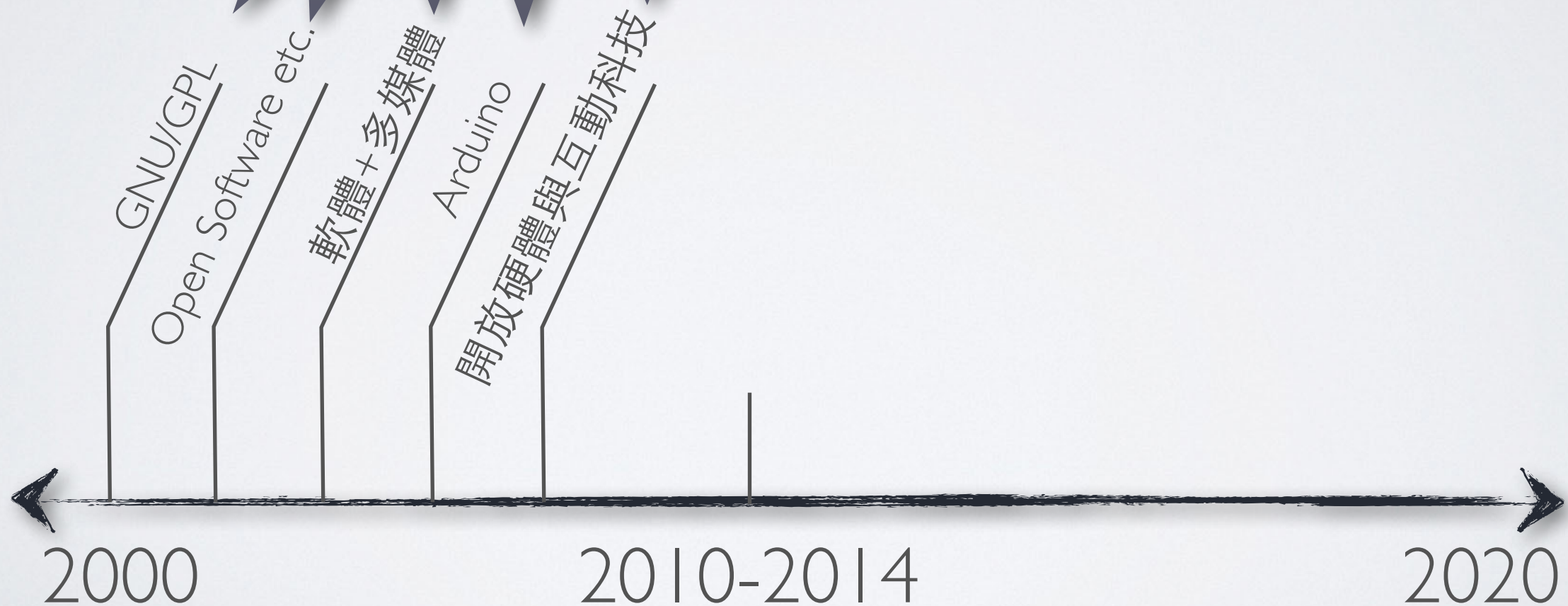
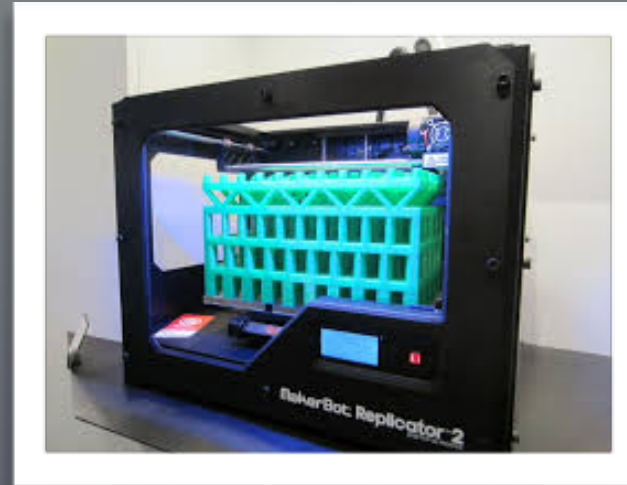
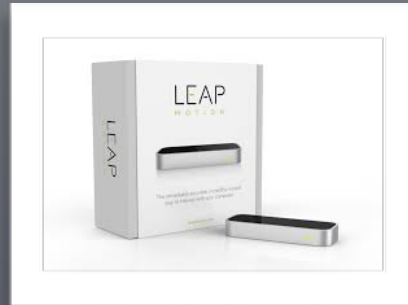
開放硬體與封閉式硬體

- 開放式硬體(軟體)設計

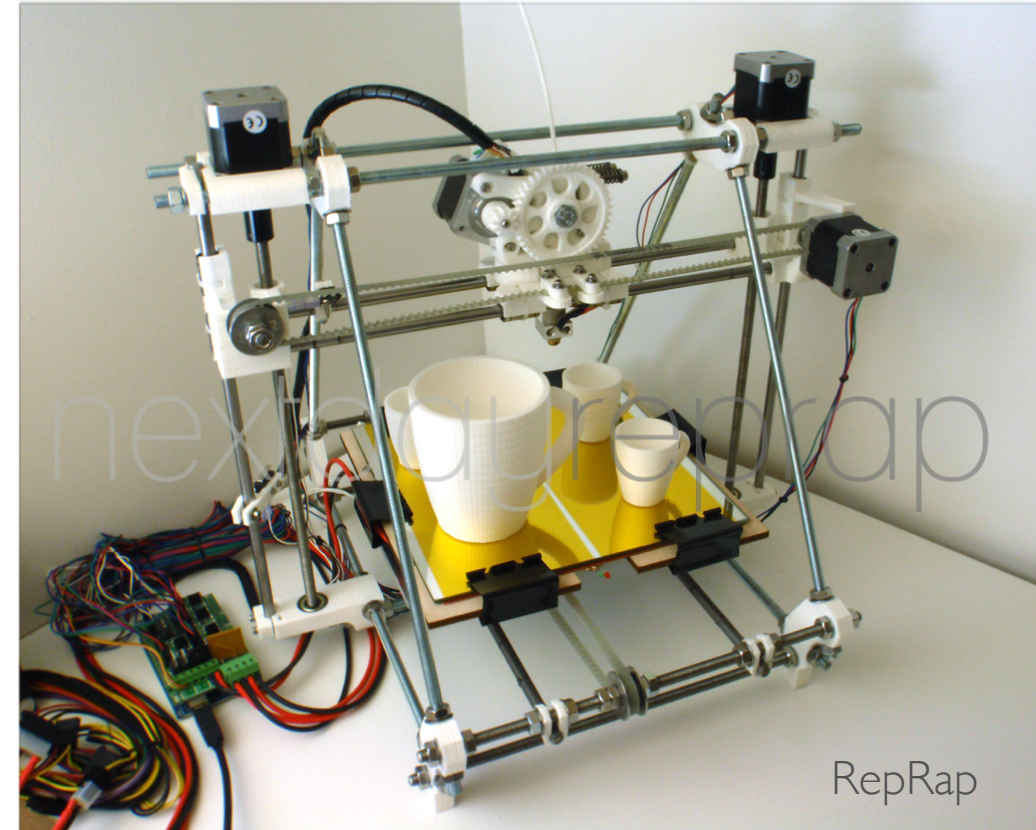
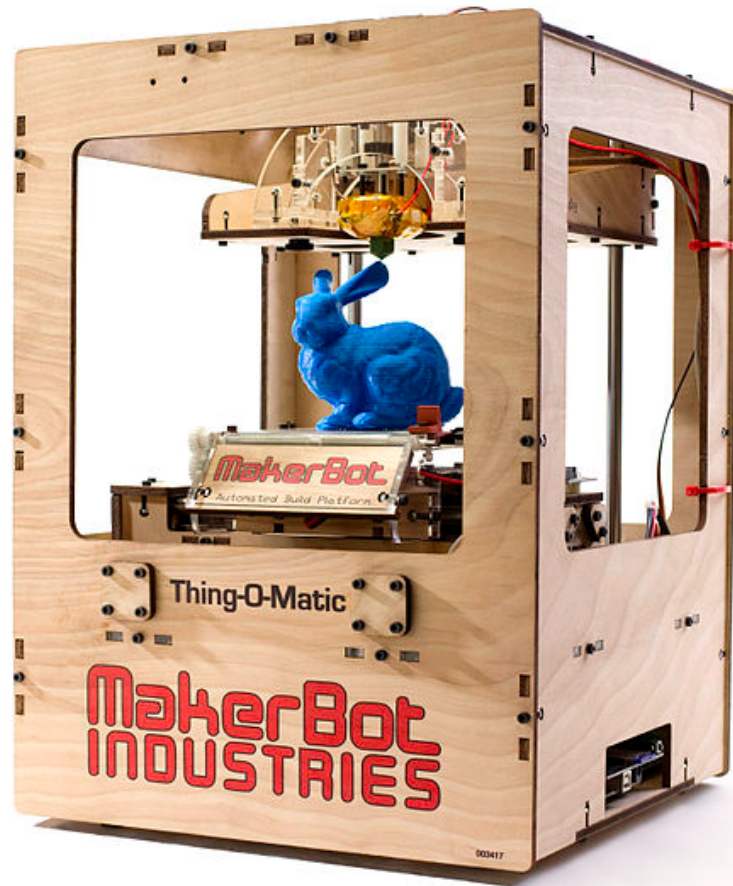
- 如Android手機平台、最近的DIY 3D Printing、小米手機...等
- 開放電路設計圖、原始程式碼，提供一些工具給喜好研發的人員使用
- 創意可更基於此開放硬體的基礎上延伸更多創意
- 減少研發、資金、除錯、產品售後服務的責任，利用消費者喜好破解的心態幫忙除錯
- 建立社群網站或直銷經營可免除銷售通路問題

timeline of
decade year

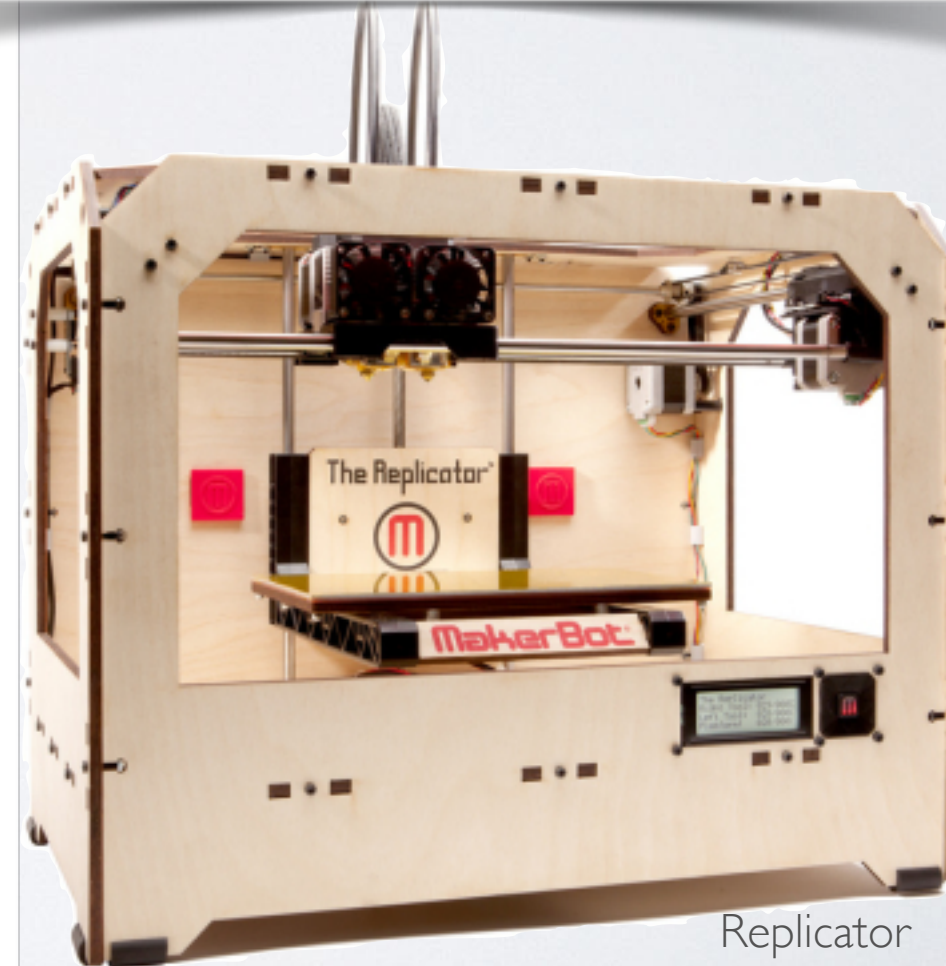
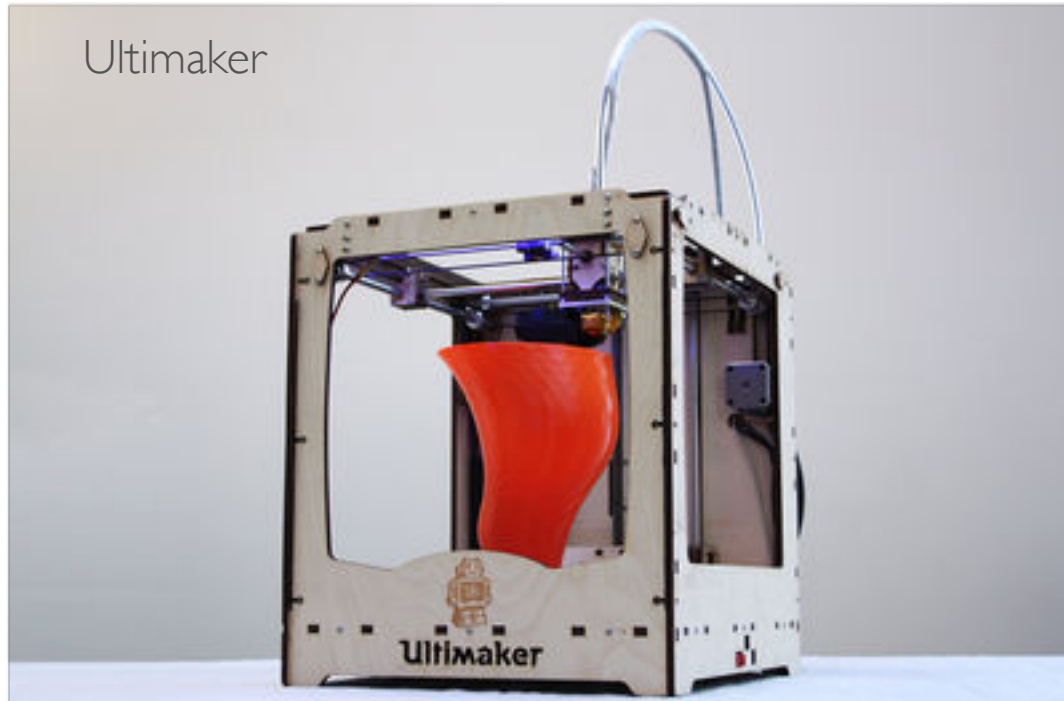
- 3D Printing
- LeapMotion



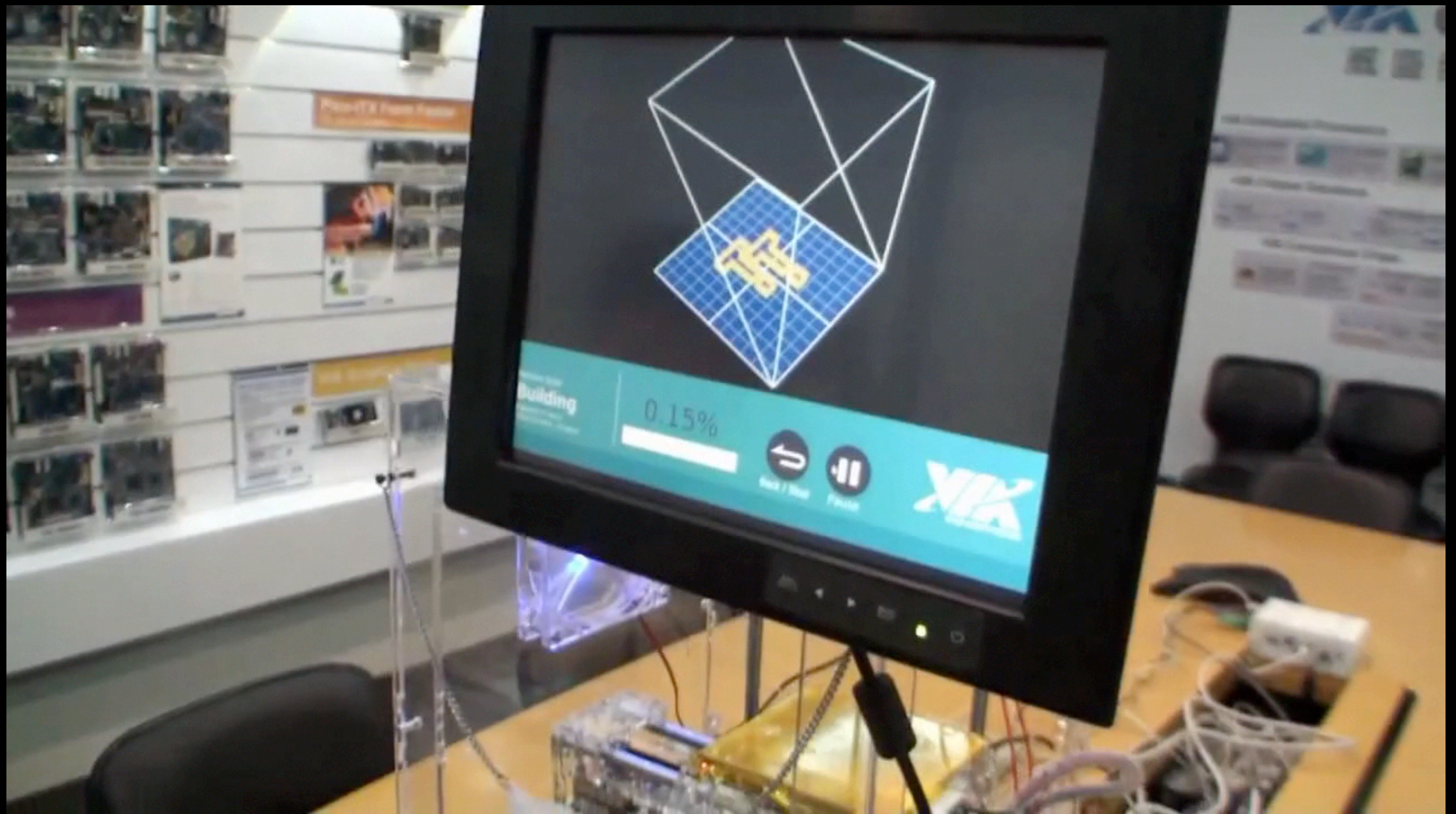
Thing-O-Matic



Ultimaker



Replicator



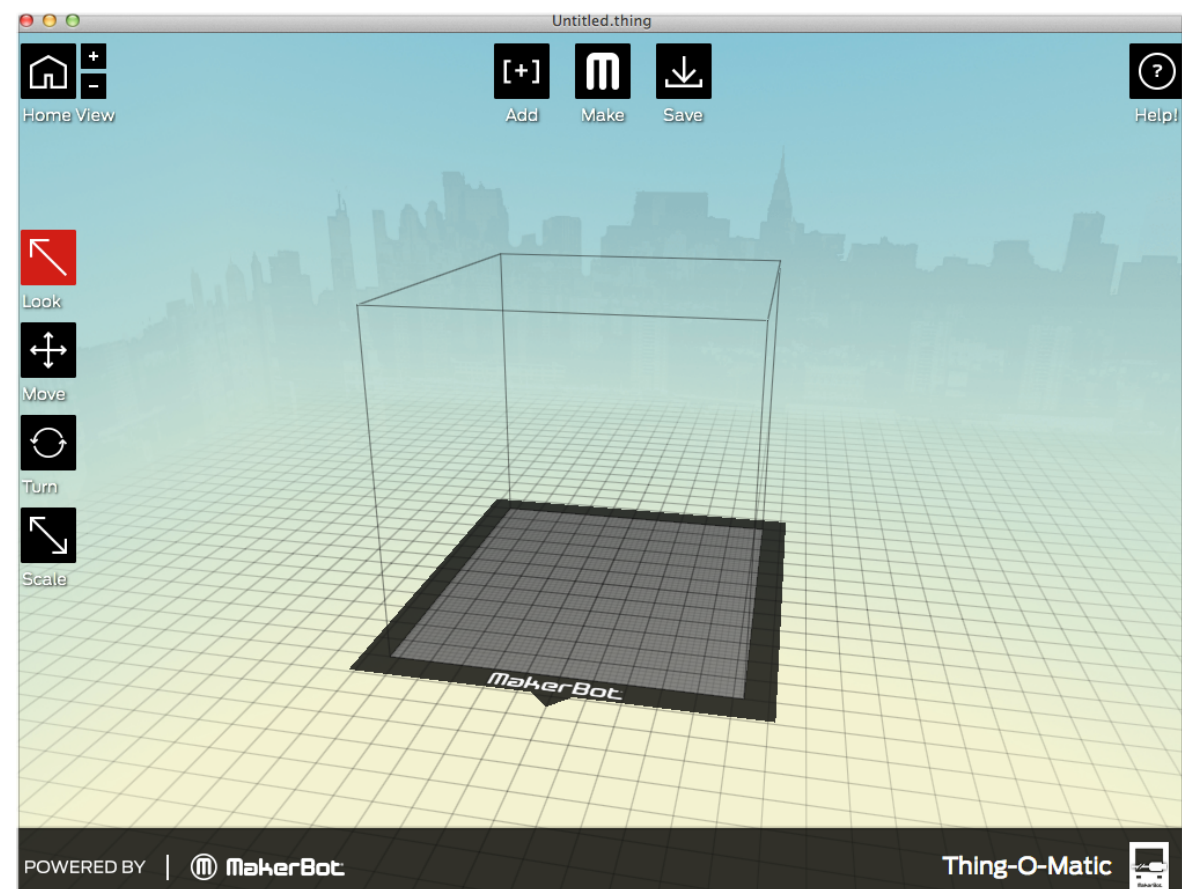
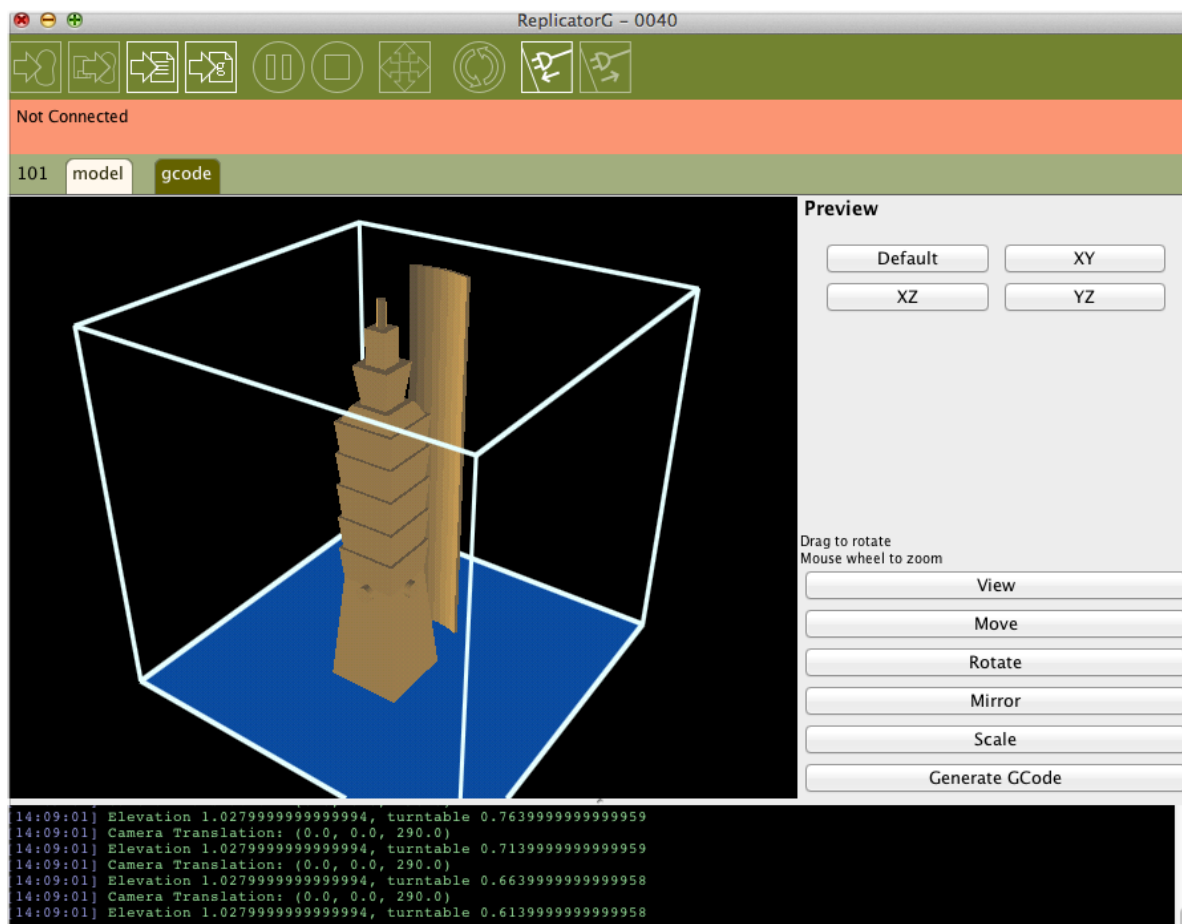
3D Printer DEMO in VIA Tech.

Hack into Software

ReplicatorG

MakerWare

VIA3DTouch



Open File



Print Setup



Power Off



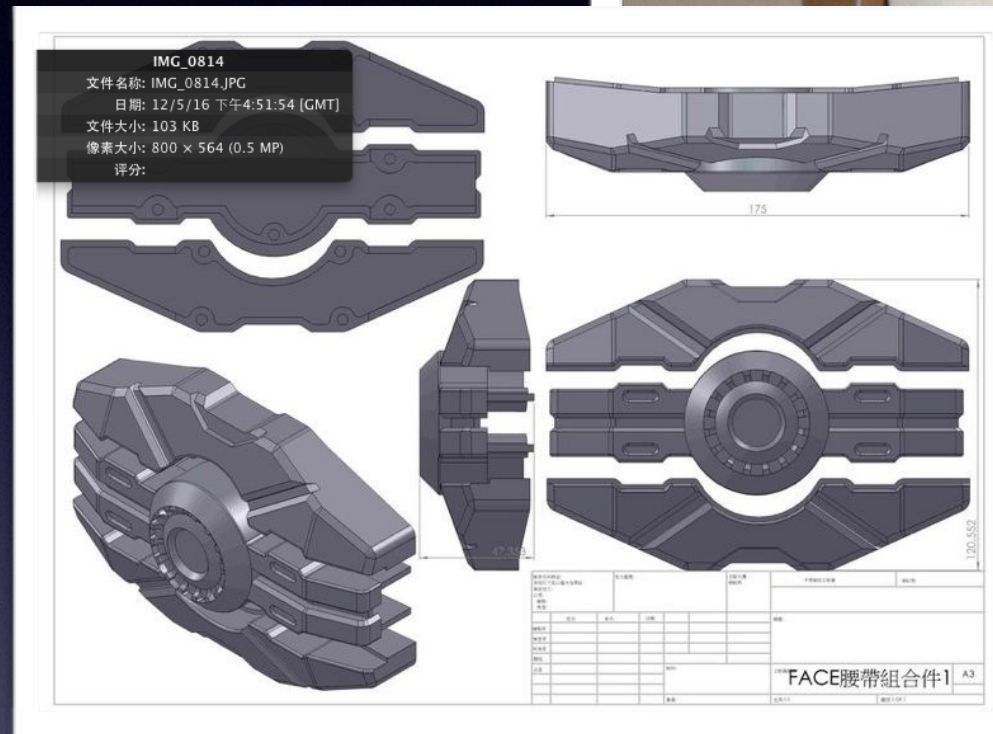
Machine State
Disconnect.

Extruder Temperature[0/260]

Platform Temperature[0/120]

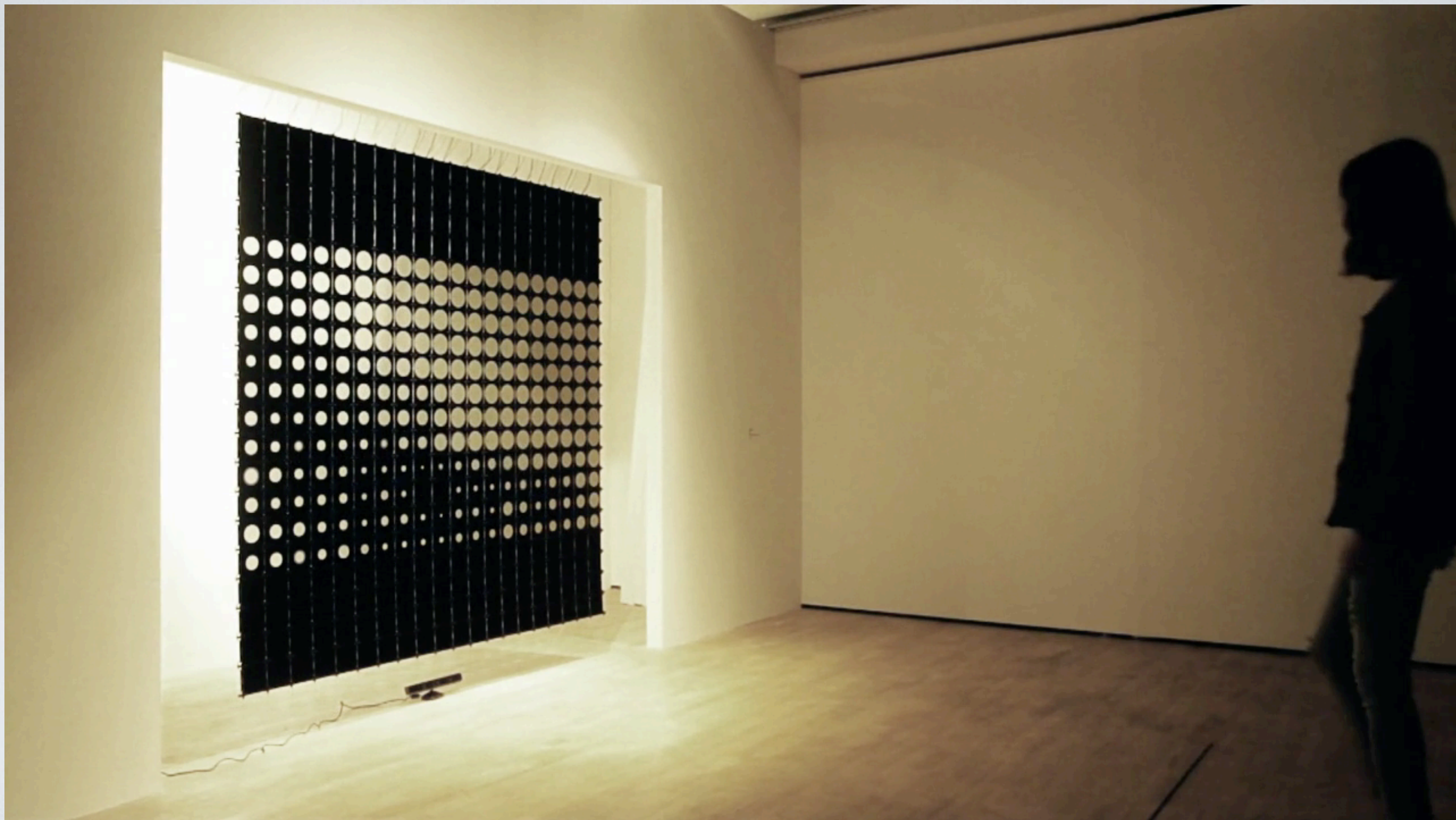


製作電影道具



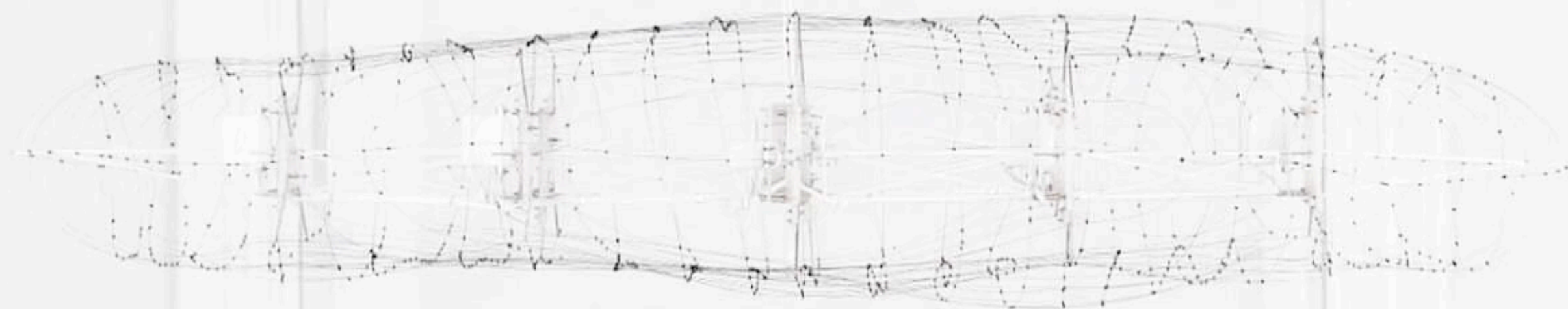
其他開放硬體製作的專案

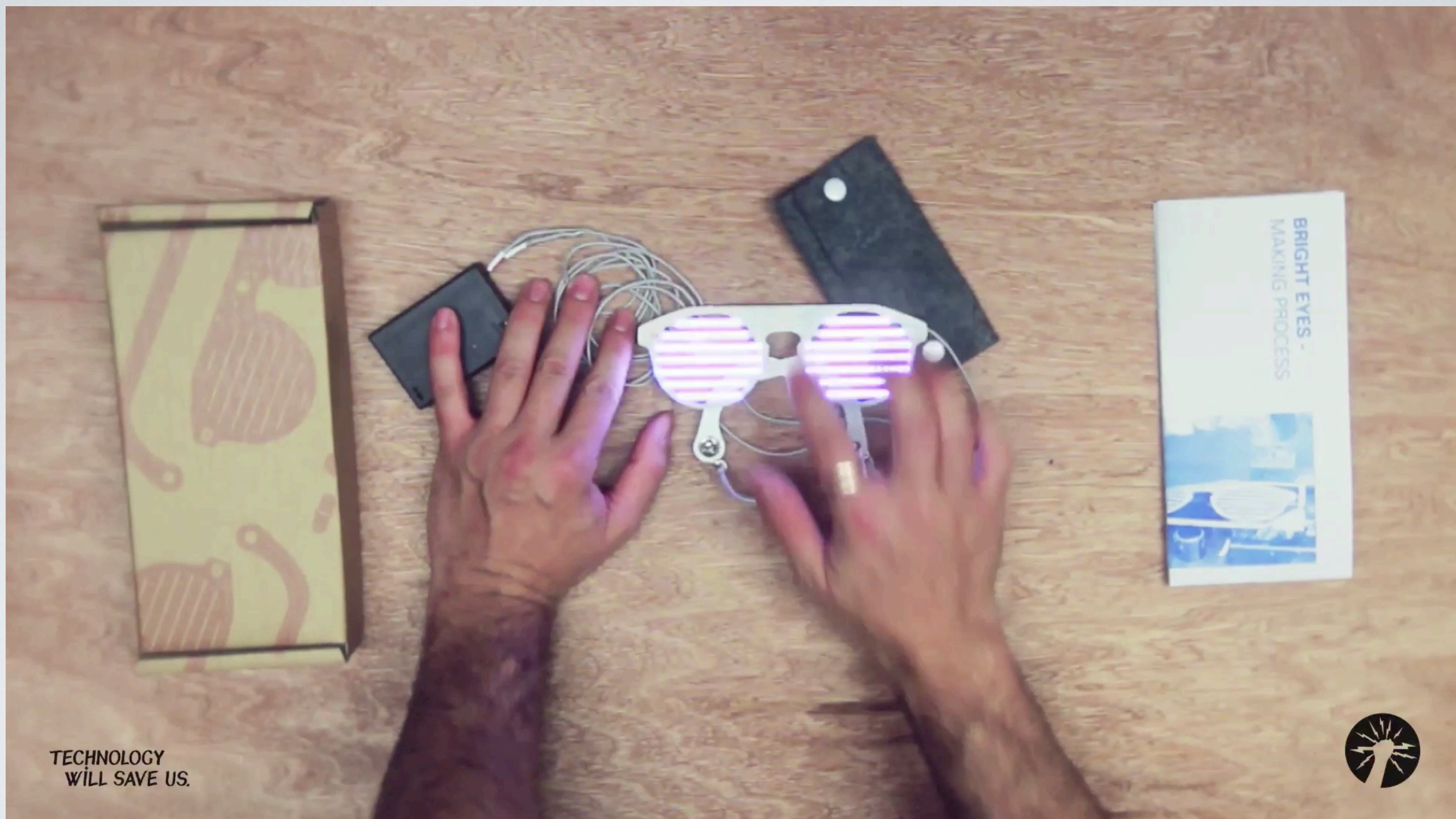
- HYBE
- Point Cloud
- Bright Eyes
- Makey Makey



TIME
TRAVELLER



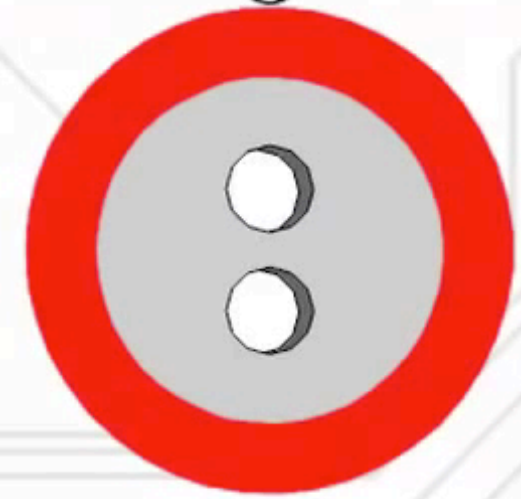
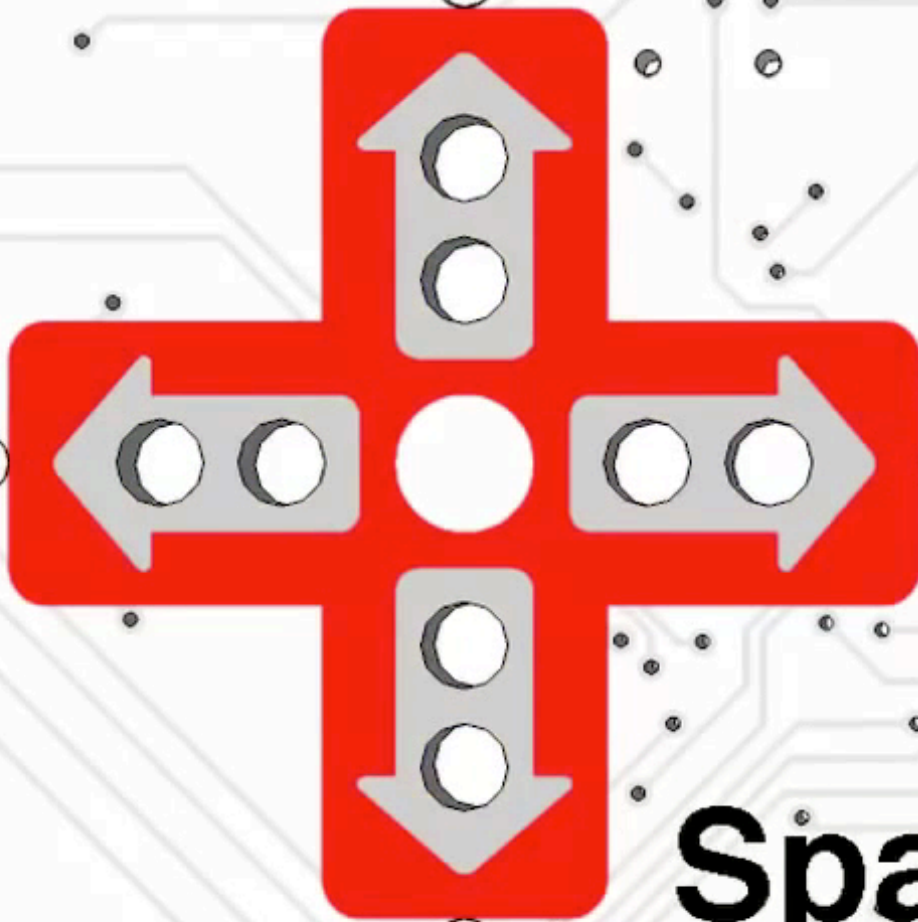




TECHNOLOGY
WILL SAVE US.



MaKeyMaKey.com



SPACE

CLICK

Space Bar

EARTH

sparkfun.com



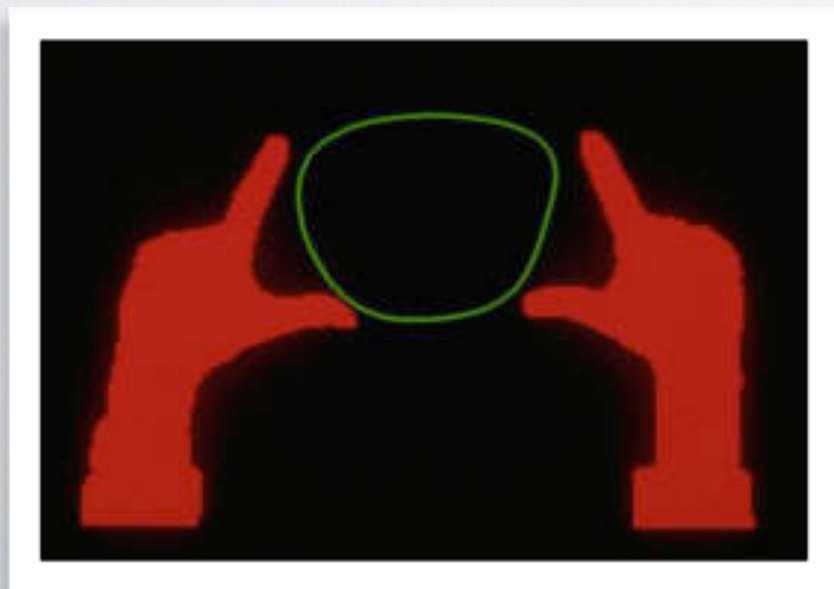
開放硬體與互動科技脈絡

- 牆
- 桌子
- 地板



最早的互動牆

- Myron Krueger
- Artificial Reality
- Video Place (1983)



<http://www.youtube.com/watch?v=dqZyZrN3PI0>

互動牆

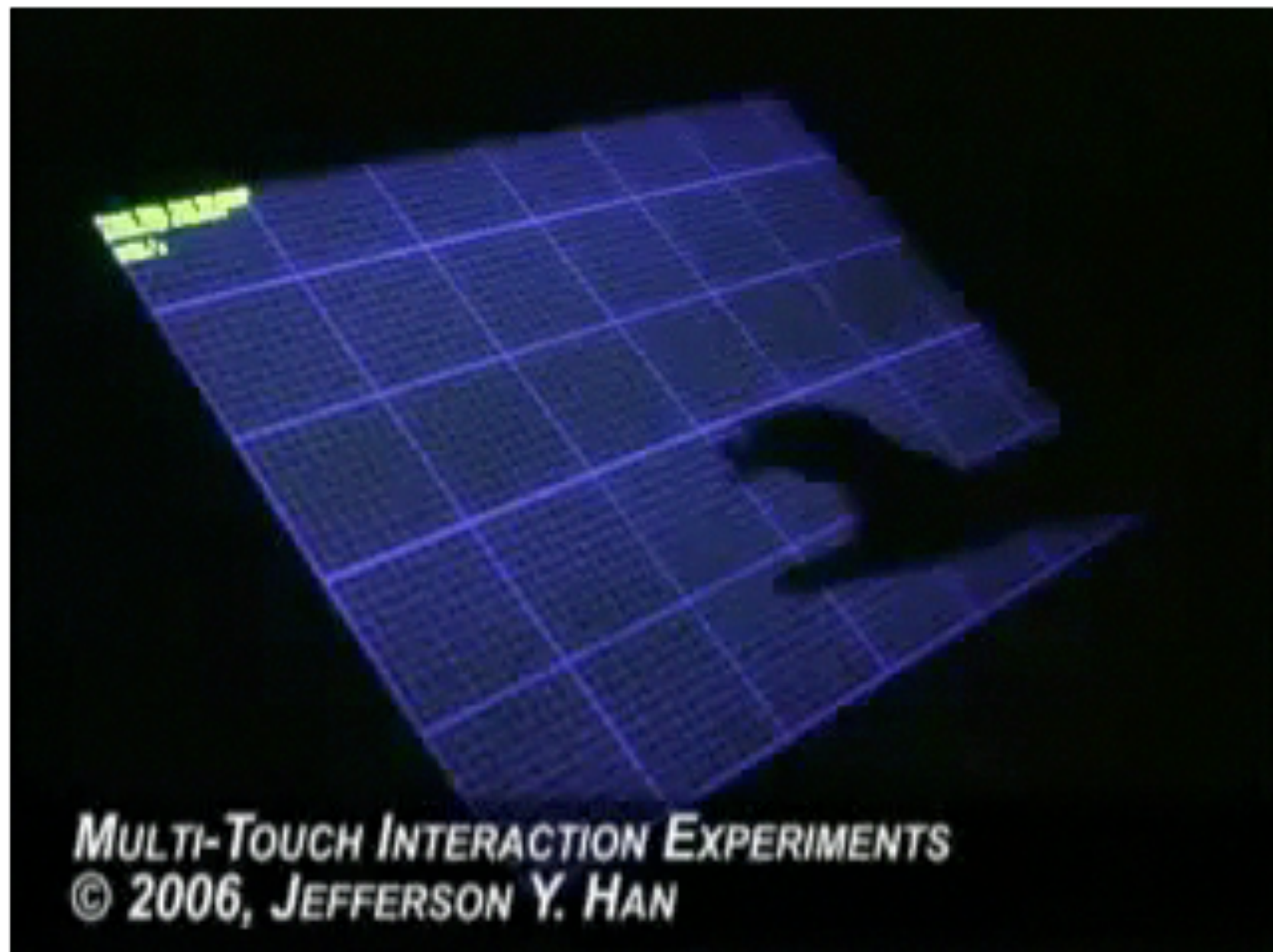


Golan Levin and Zachary

美聲演繹

<http://www.youtube.com/watch?v=GfoqiyBIndE>

互動桌

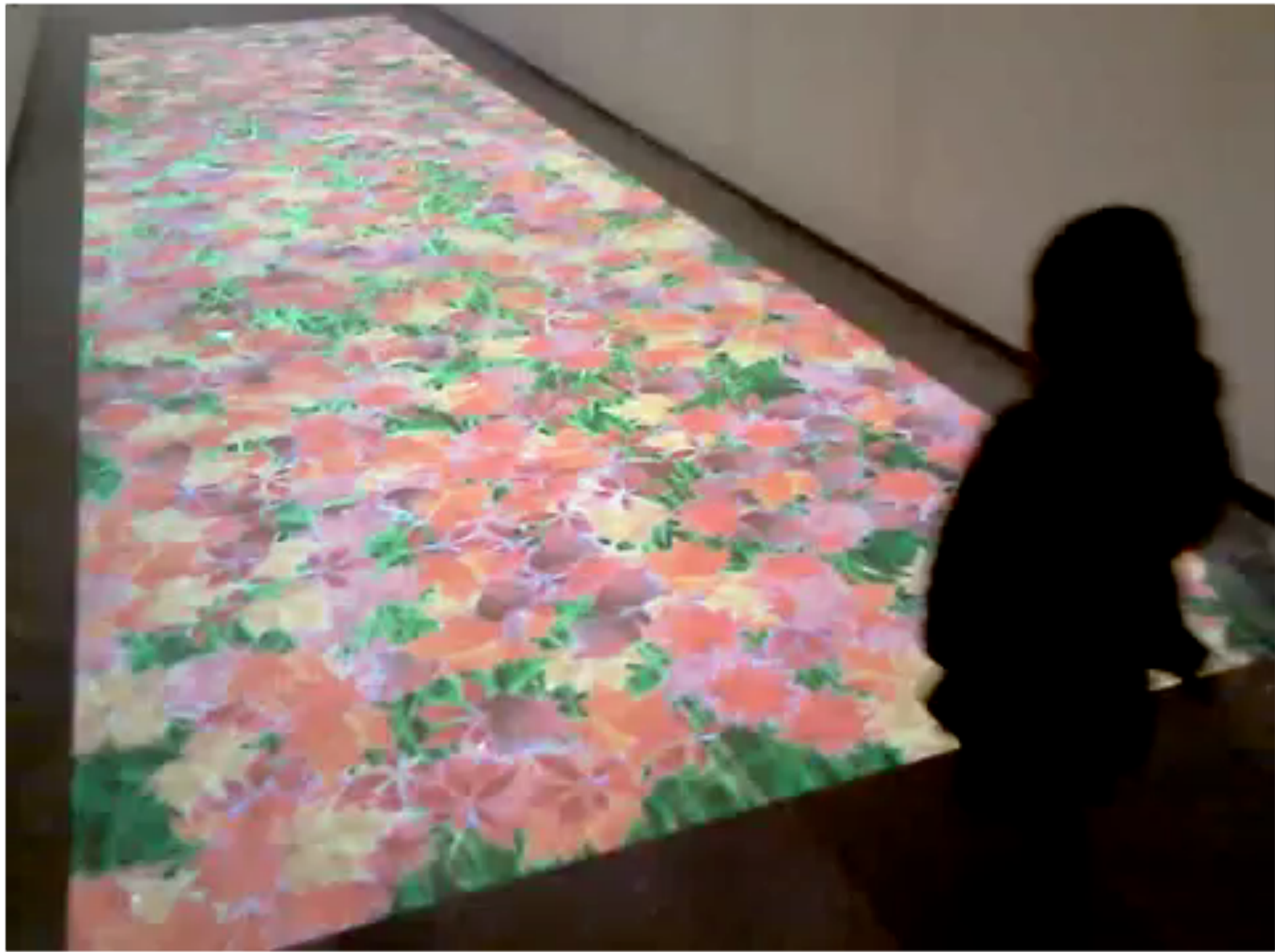


Jefferson Y. Han

多點觸控桌

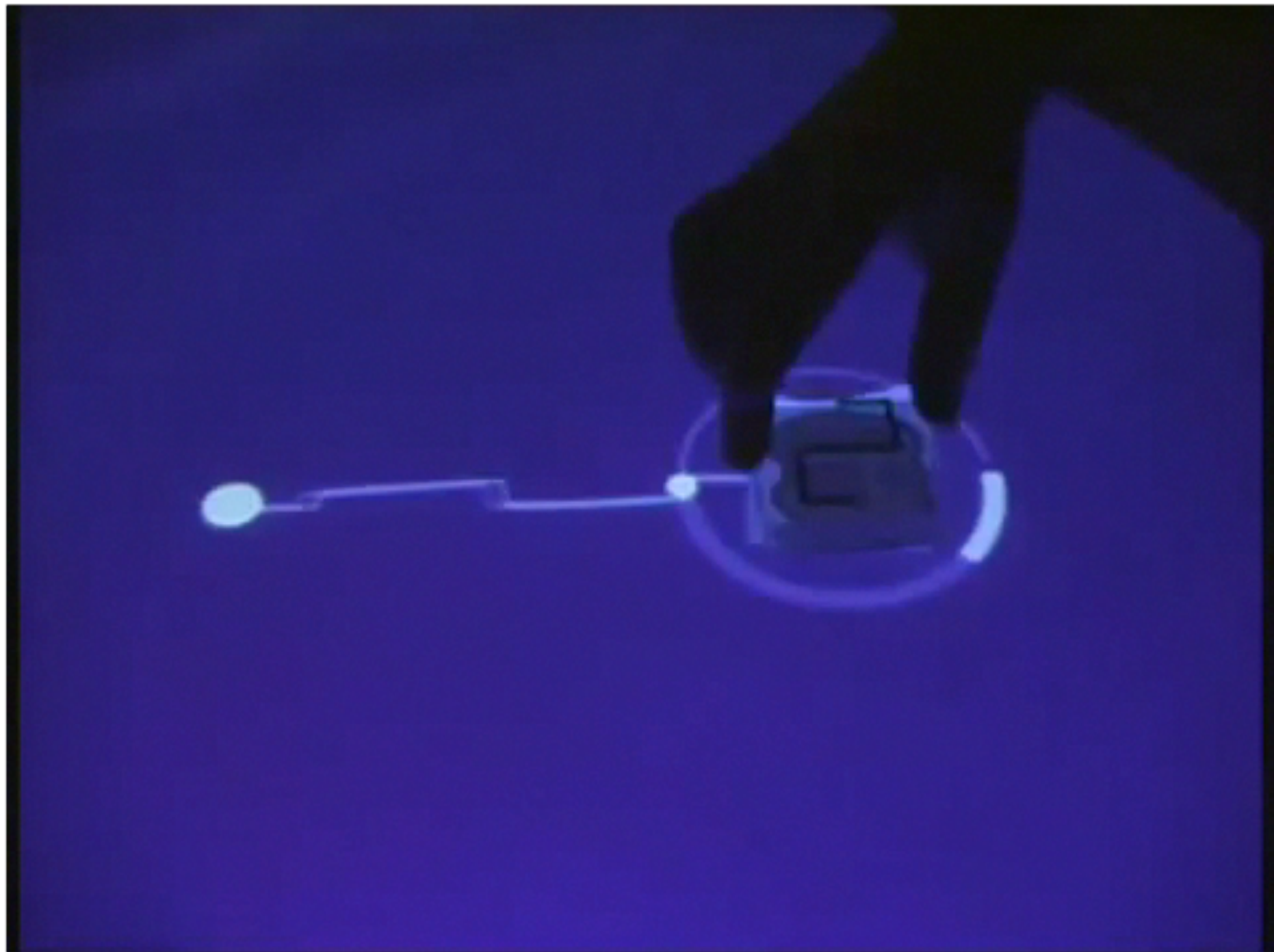
<http://www.youtube.com/watch?v=EiS-W9aeG0s>

互動地板



<http://www.youtube.com/watch?v=dOIEwxZIHVo>

REACTABLE



<http://www.youtube.com/watch?v=0h-RhyopUmc>

互動介面技術

- 軟體面
 - 透或影像辨識的互動介面(互動桌、互動牆、互動地板)
 - 用投影的方式呈現畫面，非接觸性的與畫面互動
 - PC / MAC / Phone / Tablet
- 硬體面
 - 透過感測器(溫度、濕度、光線、動作、加速度、壓力、繞曲、方向、距離、磁場等等)接收人們動作感知
 - 無線傳輸、有線傳輸
 - 接觸或非接觸、直接或間接

未來10年

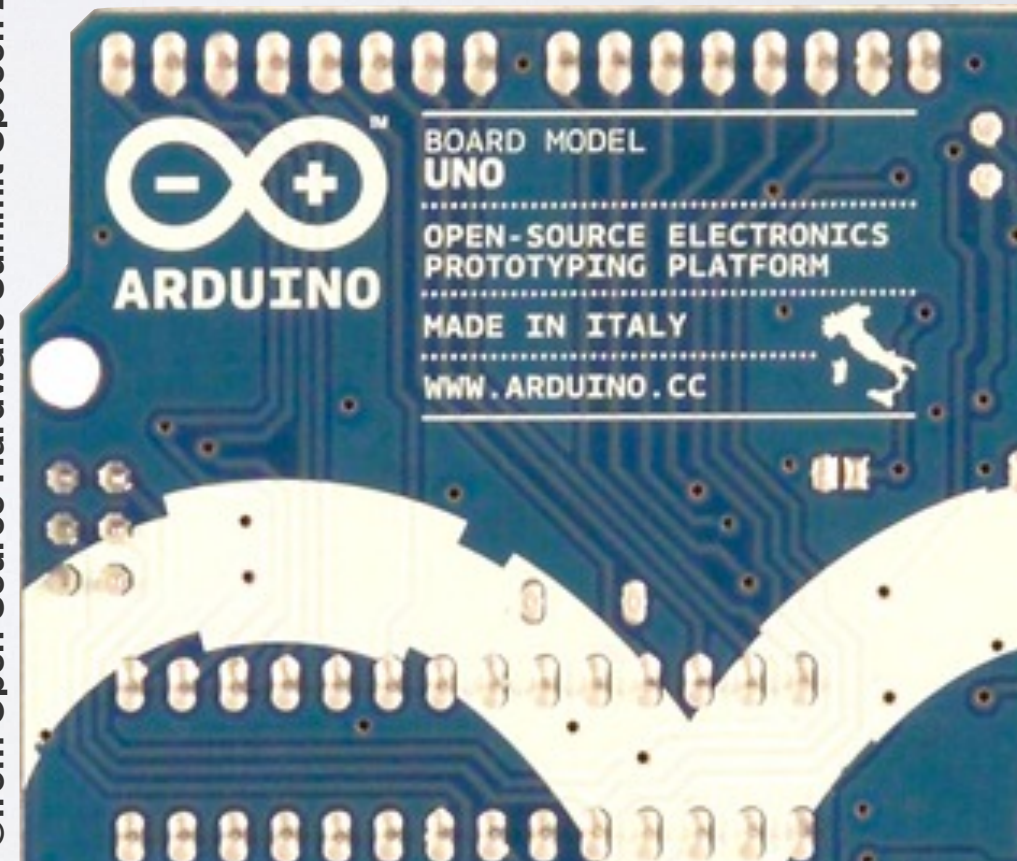
- 運用開放硬體工具達成**新型**互動科技手法已成趨勢
- 具有藝術美感的創作(產品)才能具有**獨賣增值**
- Arduino = 幫助各位踏進互動科技的一小步

2013

2023

ARDUINO

@from Open Source Hardware Summit Speech 2011





Daniela Antonietti
CFO

Massimo Banzi
CEO/Product Manager
Professor at SUPSI and CIID Copehagen

David Cuartielles
Education /WEB Services
Professor at K3 University of Malmo

Tom Igoe
Documentation
Professor at ITP, New York University

Gianluca Martino
Hardware Design, Mfg and Distrivution

David A. Mellis
Software
PHd Student at MIT Media Lab

認識ARDUINO的誕生

- Processing.org
- Wiring.org.co
- Arduino.cc

@from Open Source Hardware Summit Speech



PROCESSING.ORG

- 起源於2001年
- 以Java程式語言為基礎的視覺藝術軟體
- OpenSource
- MIT Media Lab
- Windows、Mac OS、Linux
- Coding is Art

Explode | Processing 1.5.1

STANDARD

Explode

```
/**
 * Explode
 * by Daniel Shiffman.
 *
 * Mouse horizontal location controls breaking apart of image and
 * Maps pixels from a 2D image into 3D space. Pixel brightness controls
 * translation along z axis.
 */

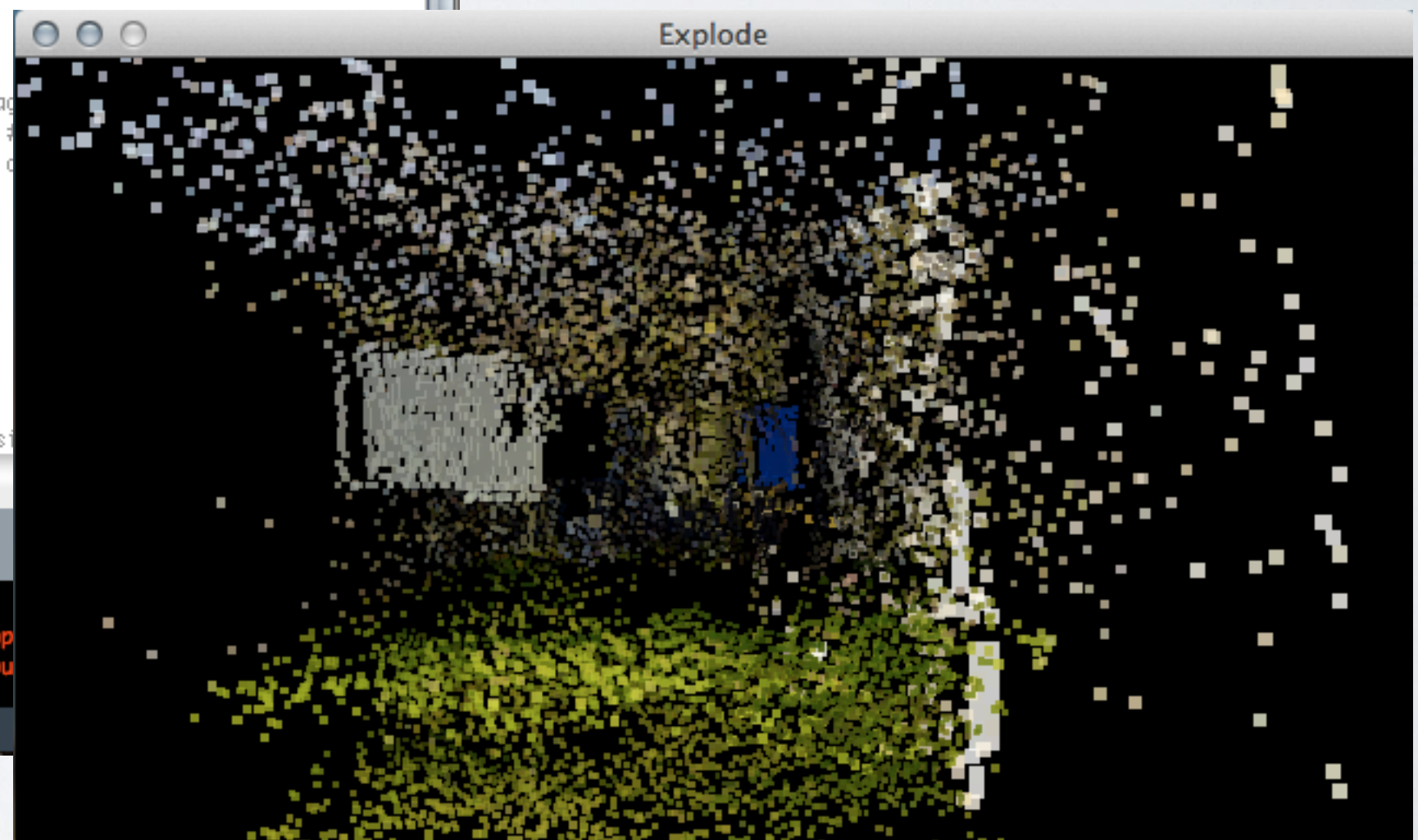
PImage img; // The source image
int cellsize = 2; // Dimensions of each cell in the grid
int columns, rows; // Number of columns and rows in our system

void setup() {
  size(640, 360, P3D);
  img = loadImage("eames.jpg"); // Load the image
  columns = img.width / cellsize; // Calculate # of columns
  rows = img.height / cellsize; // Calculate # of rows
}

void draw() {
  background(0);
  // Begin loop for columns
  for (int i = 0; i < columns; i++) {
    // Begin loop for rows
    for (int j = 0; j < rows; j++) {
      int x = i*cellsize + cellsize/2; // x position
      int y = j*cellsize + cellsize/2; // y position
      float z = img.get(x, y); // Get brightness of pixel
      // Map brightness to z position
      z = map(z, 0, 255, 0, 100);
      // Create a small square at the new position
      fill(z, 255, 255, 10);
      rect(x, y, cellsize, cellsize);
    }
  }
}
```

2011-12-06 01:03:49.189 java[21291:5913] Can't open /Library/InputManagers/MultiClutchInputManager.bundle

1



PROCESSING VISUALS



<http://www.youtube.com/watch?v=AQr0tIQy9CI>

WIRING.ORG.CO

- 起源於2003年
- Arduino的前身
- 首創OpenSource電路原型開發平台
- 使用Processing IDE作為程式開發環境
- 公開bootloader、電路設計、編譯器、燒錄器軟體、IDE介面原始碼、眾多感測器連接範例



What will YOU do with the **W**?

Wiring
get on board.

- » Download Wiring
- » Getting the Wiring hardware
- » Browse Tutorials
- » Play with Examples

sketch_dec06a | Wiring 0100

sketch_dec06a

```
void setup()
{

}

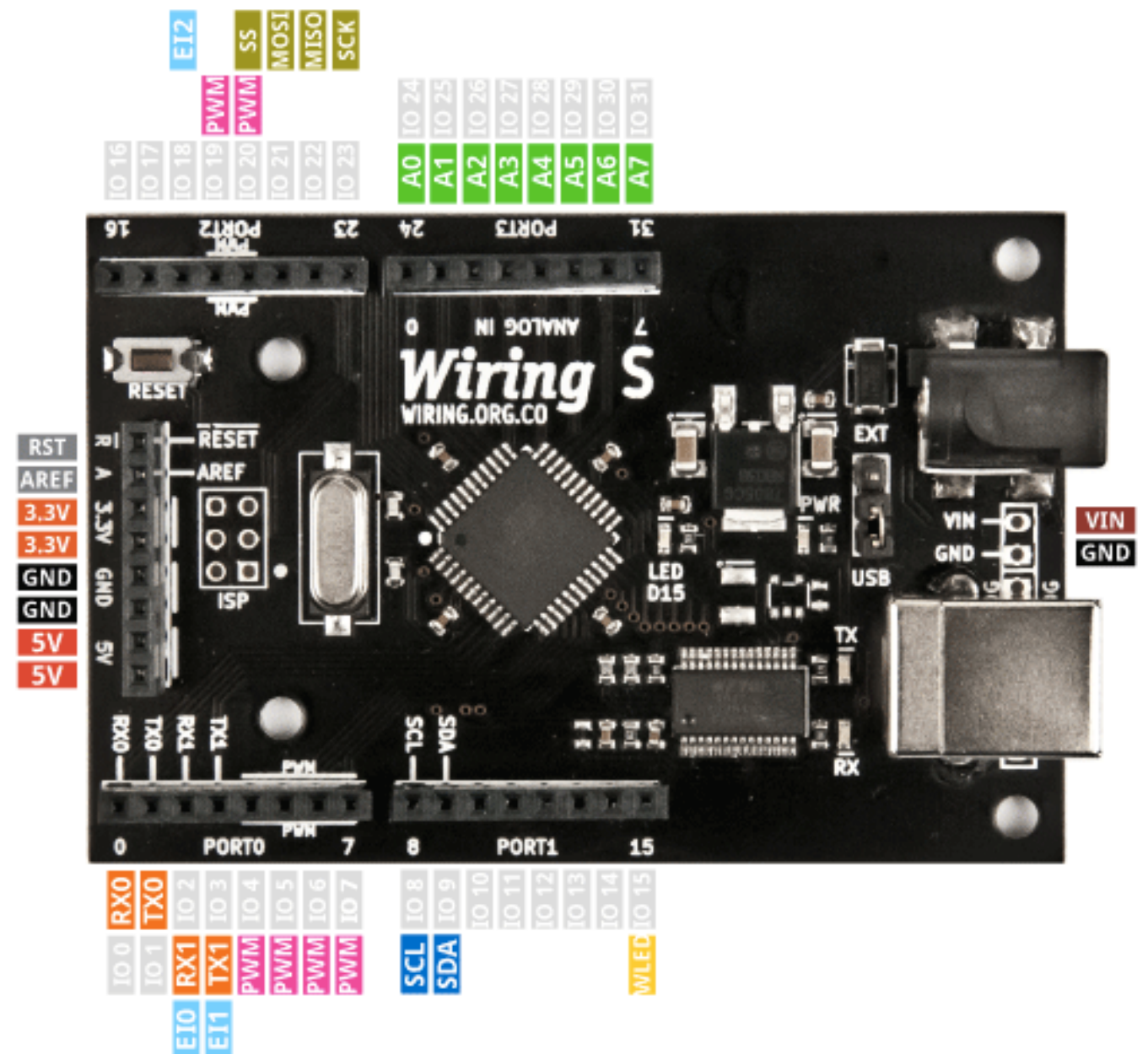
void loop()
{

}
```

Done Uploading.

Binary sketch size: 1922 bytes (of a 30720 byte maximum) - 6%
Serial monitor started after upload (Wiring -> Preferences)

6board: Arduino Duemilanove or Nano w/ ATmega328 @ 16 MHz on /dev/t



LEGO HELLO WORLD



<http://www.youtube.com/watch?v=zX09WnGU6ZY>

ARDUINO.CC

- 創立於2004年
- 結合Processing與Wiring的優點，採用更便宜的架構
- 當時的主要對手為BasicStamp
- 採用Atmel AVR的相關OpenSource軟體
- 簡單使用、零件成本便宜、上手速度快、討論區完整、容易複製
- 眾多的應用範例與Libraries

Blink | Arduino 1.0-beta1

Blink

```
/*
Blink
Turns on an LED on for one second, then off for one second, repeatedly.

This example code is in the public domain.
*/

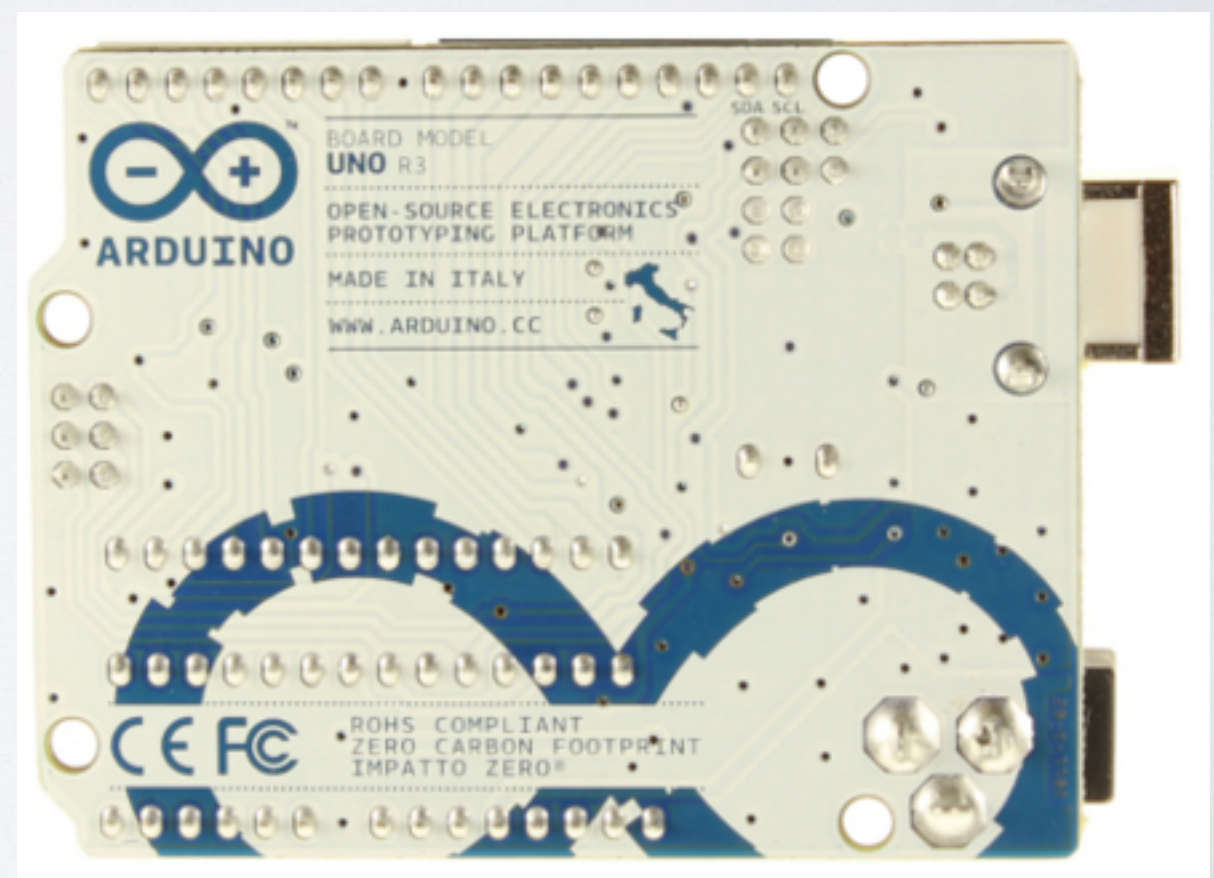
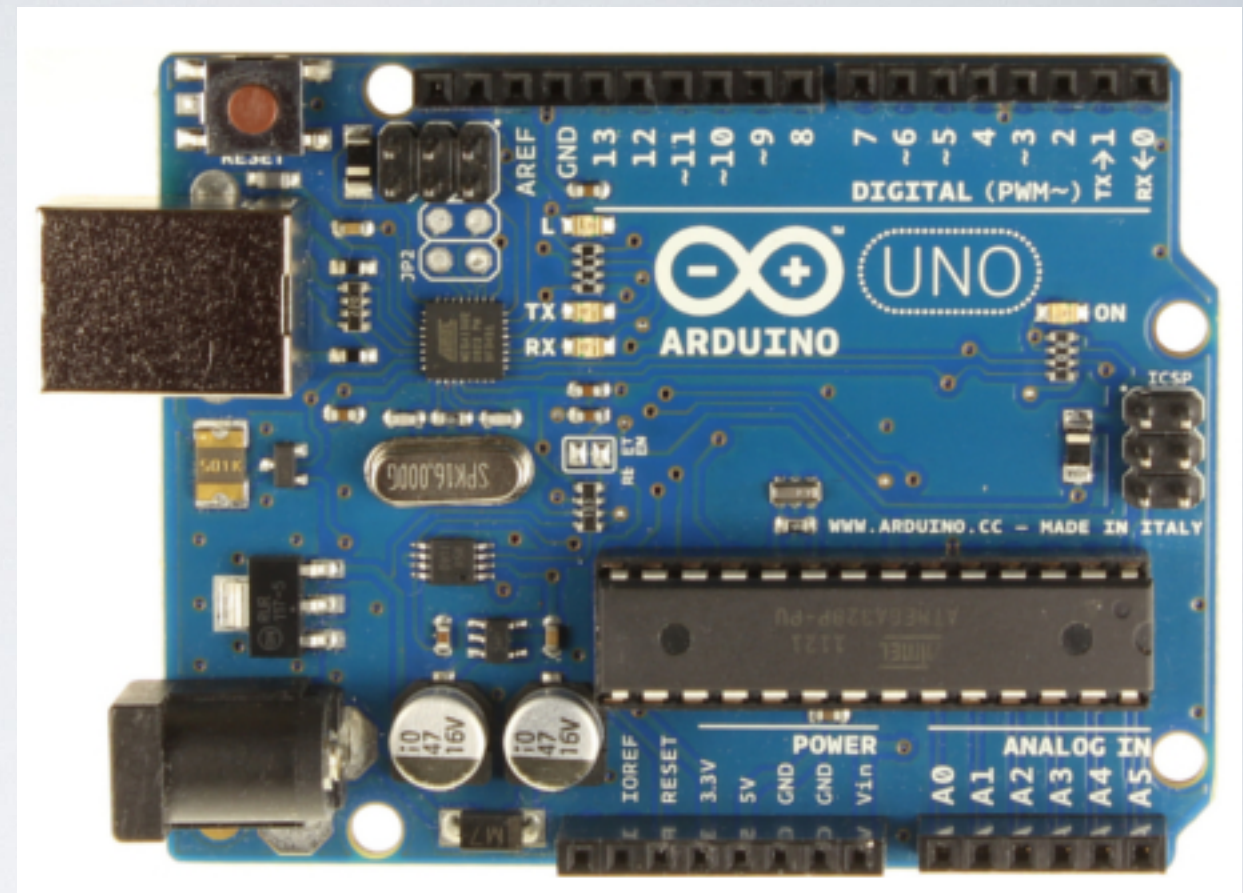
void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH); // set the LED on
  delay(1000);            // wait for a second
  digitalWrite(13, LOW);  // set the LED off
  delay(1000);            // wait for a second
}
```

Done compiling.

Binary sketch size: 1010 bytes (of a 30720 byte maximum)

1

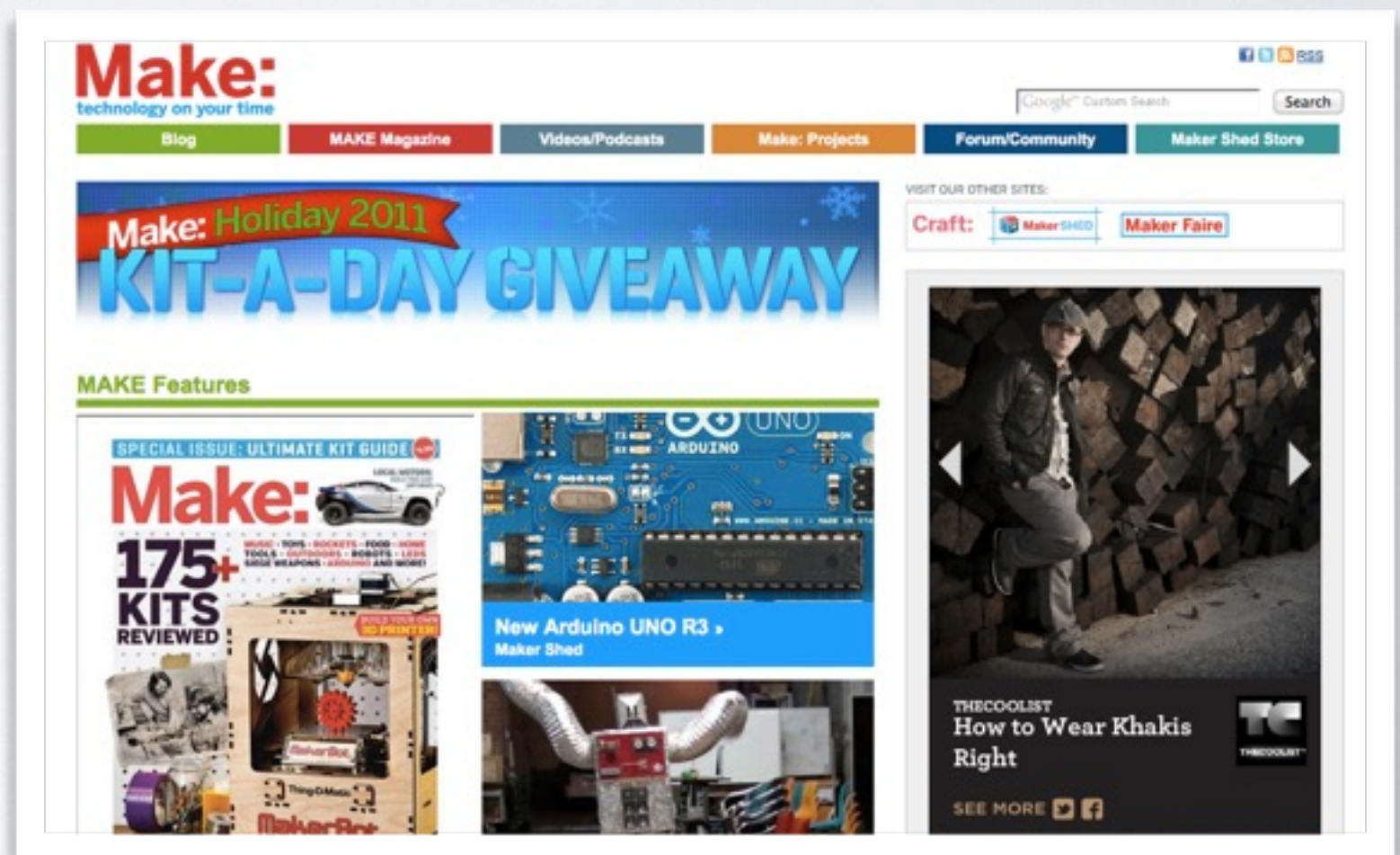


ARDUINO社群的形成

- AVR Freaks 大量的DIY玩家討論AVR
- Avrdude , avrgcc, avr-g++, java 開源軟體為基礎
- Arduino 軟硬體完全開放，不留任何機密
- MakeMagaize, Instructables.com DIY教學網站大量分享應用範例，破解心得
- Sparkfun.com, seeedstudio.com, adafruit.com 提供完整的DIY套件、零件、電路板、模組、擴充板，甚至提供範例程式碼、

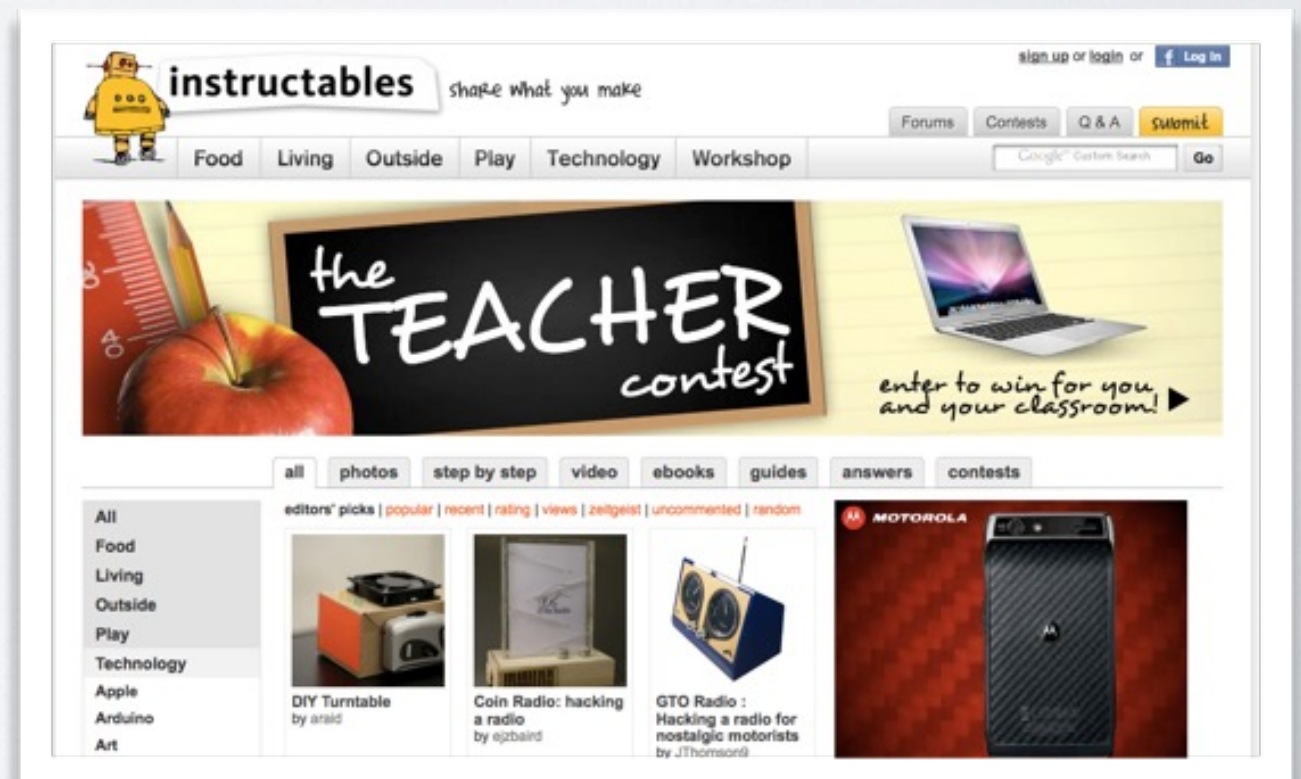
MAKE:MAGAZINE

- DIY月刊/線上討論/教學/影片
- 每期都有電子DIY的專題報導
- 專案製作教學與材料販賣相連
- 提供高畫質教學影片
- 熱絡的DIY討論區
- 定期舉辦工作坊
- 年度DIY創意競賽



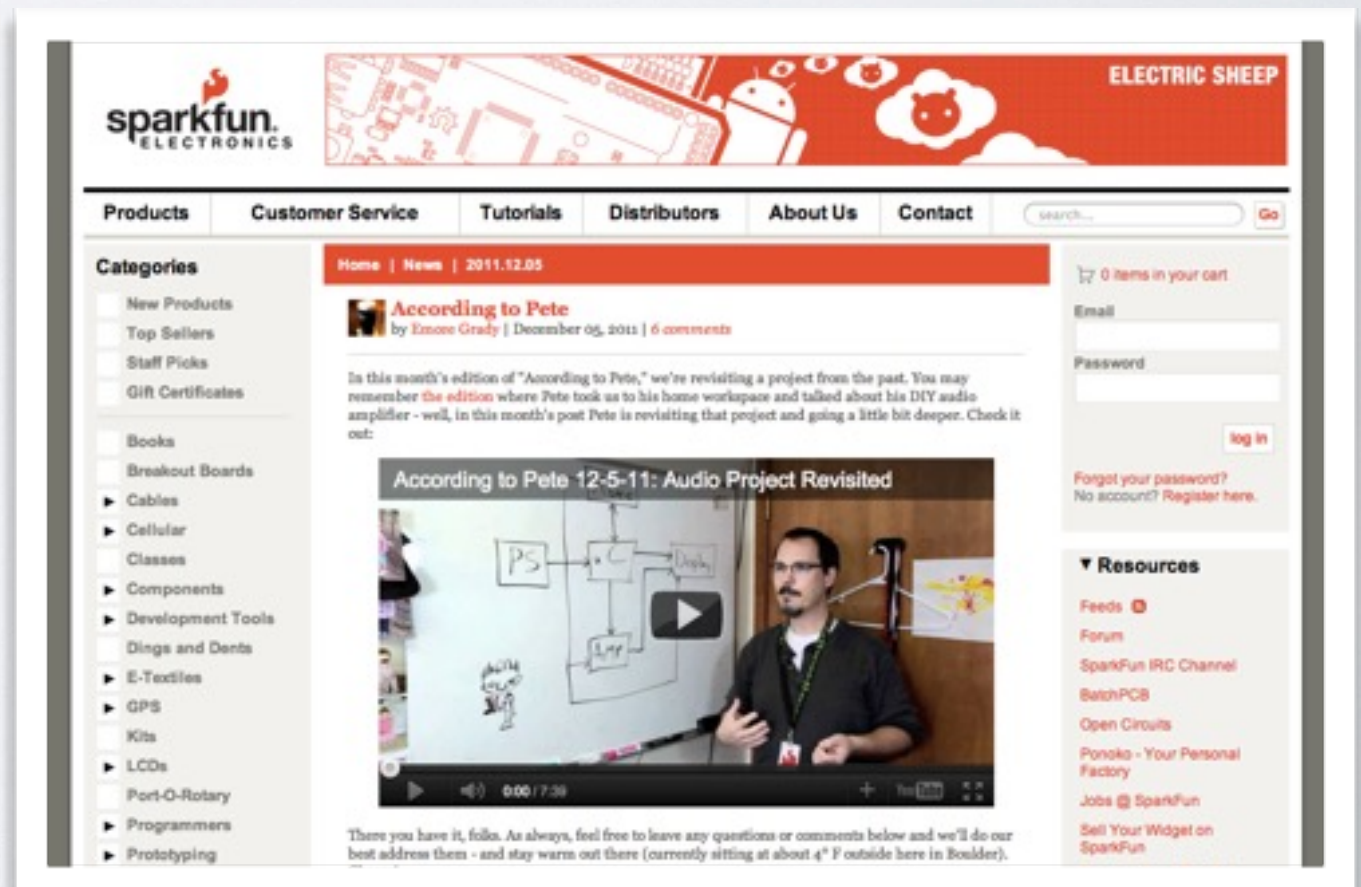
INSTRUCTABLES.COM

- DIY製作分享平台
- 會員可下載完整製作過程與材料清單[pdf]
- DIY範圍廣：美食、生活、戶外、科技、玩樂
- 適合樂於分享創意的作者
- 上萬篇DIY創意
- 分類清楚
- 入會兩年只需\$40美元



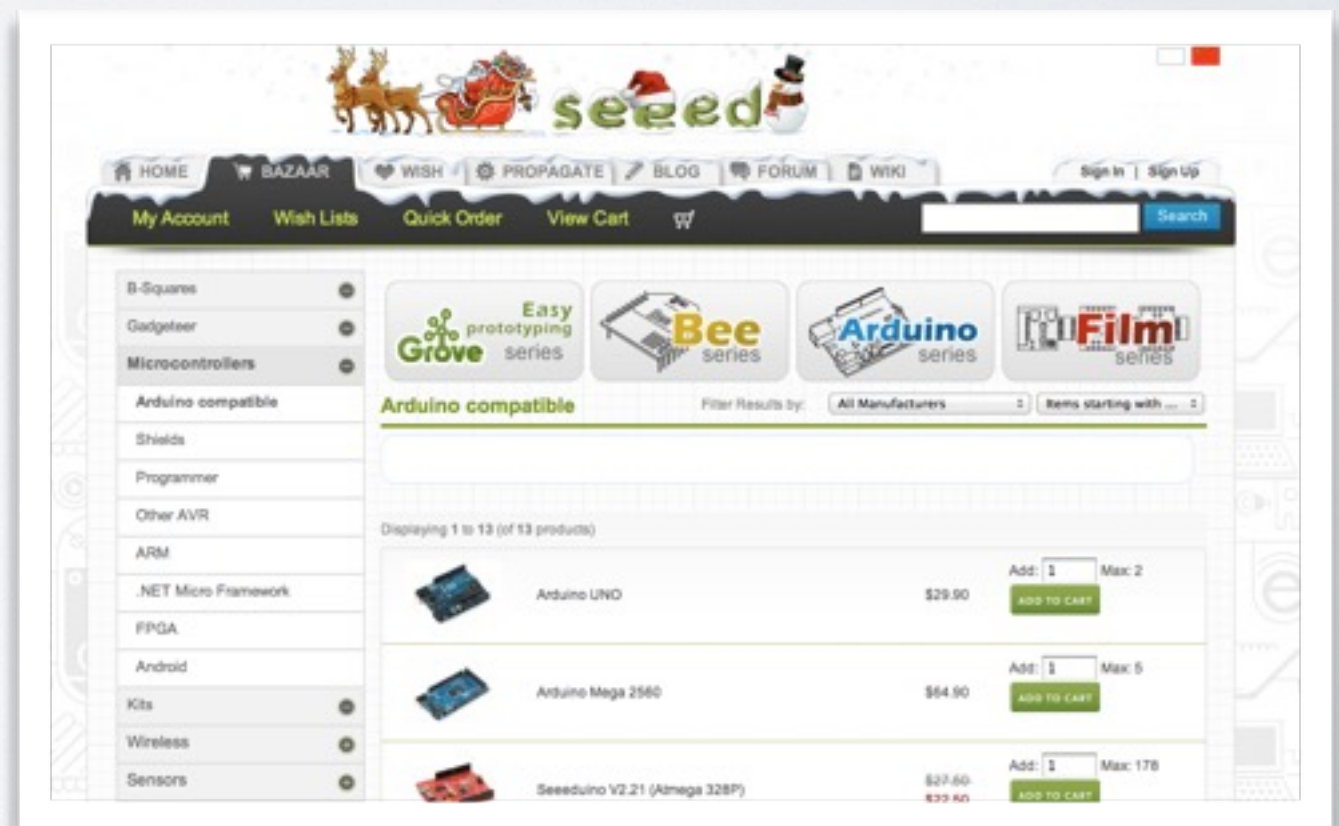
SPARKFUN.COM

- 最完整的DIY套件、模組、開發板、零件販賣商
- 套件、模組都有相關教學、範例程式碼
- 自行研發DIY模組與PCB板設計
- 每項產品都有豐富的討論串
- 發貨速度快，配合國際貨運最快2天到貨
- 即時上架最新的開發模組
- 可販賣自行研發的套件，需附



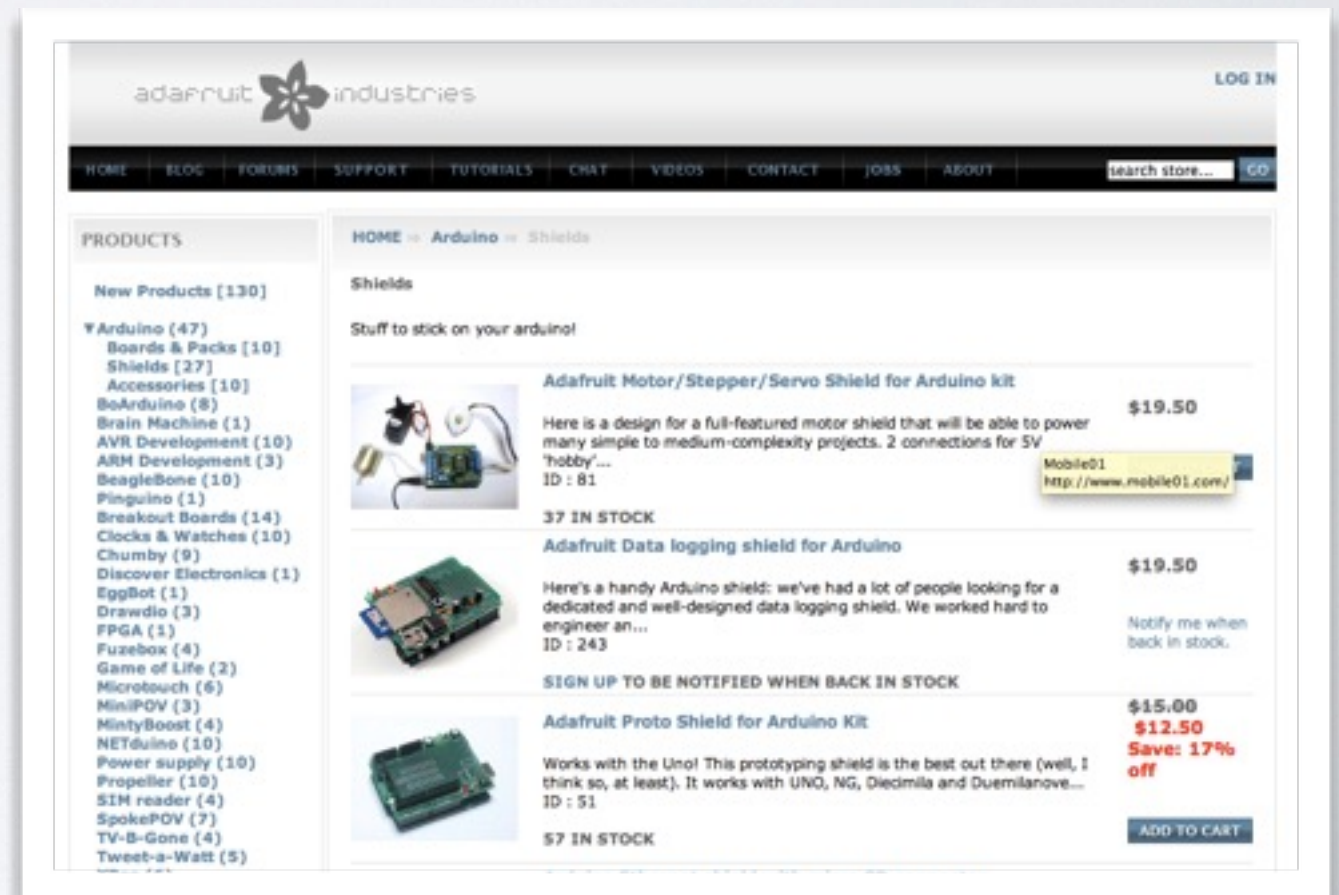
SEEEDSTUDIO.COM

- Hacker最愛，最多的特殊模組套件
- Arduino延伸版本匯集地
- 眾多的擴充板套件
- 自行研發的PCB板設計
- 機器人套件較多
- 可代為設計電路原型



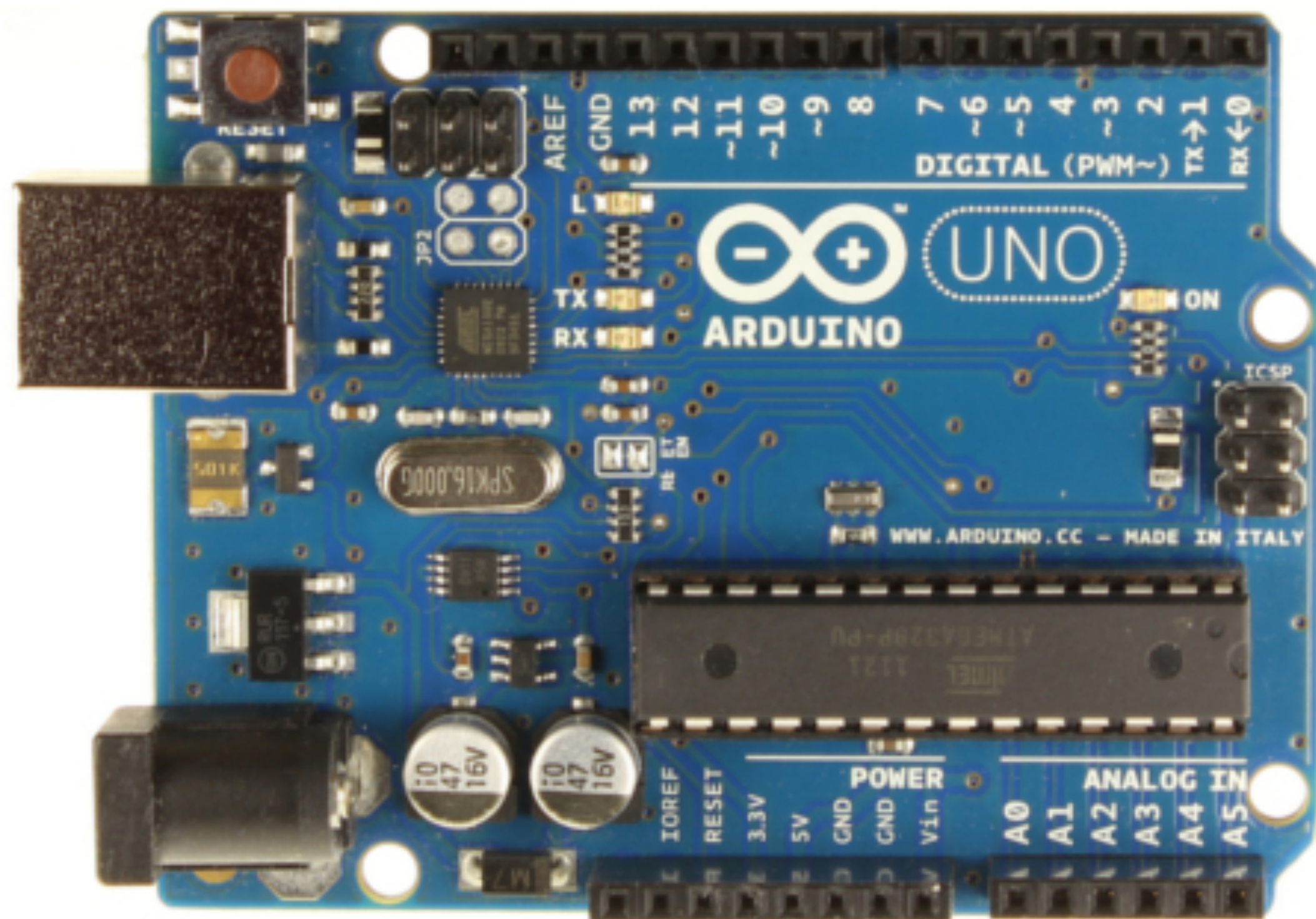
ADAFRUIT.COM

- 以OpenSource Hardware為主的套件與元件銷售
- 自行設計Open Source Hardware擴充板
- 豐富的教學與影片
- 價格最為合理便宜
- 工作坊教學套件居多



ARDUINO書籍

- 入門：Getting Started with Arduino/**踏進互動科技世界-使用 Arduino**
- **超圖解Arduino互動設計入門**
- 範例：Making Things Talk
- 秘技：Arduino CookBook
- 核心：Arduino Internals 或 Introduction to Embedded Systems: Using ANSI C and Arduino Development Environment
- 無線：Building Wireless Sensor Networks/ **建置無線感測網路**
- 機器人：Make:Arduino Bots and Gadgets
- 語法：Beginning Ardino Programming
- ADK：Beginning Android ADK with Arduino [2012/3/26]
- iOS：iOS Sensor Apps with Arduino
- 互動概念：Programming Interactivity

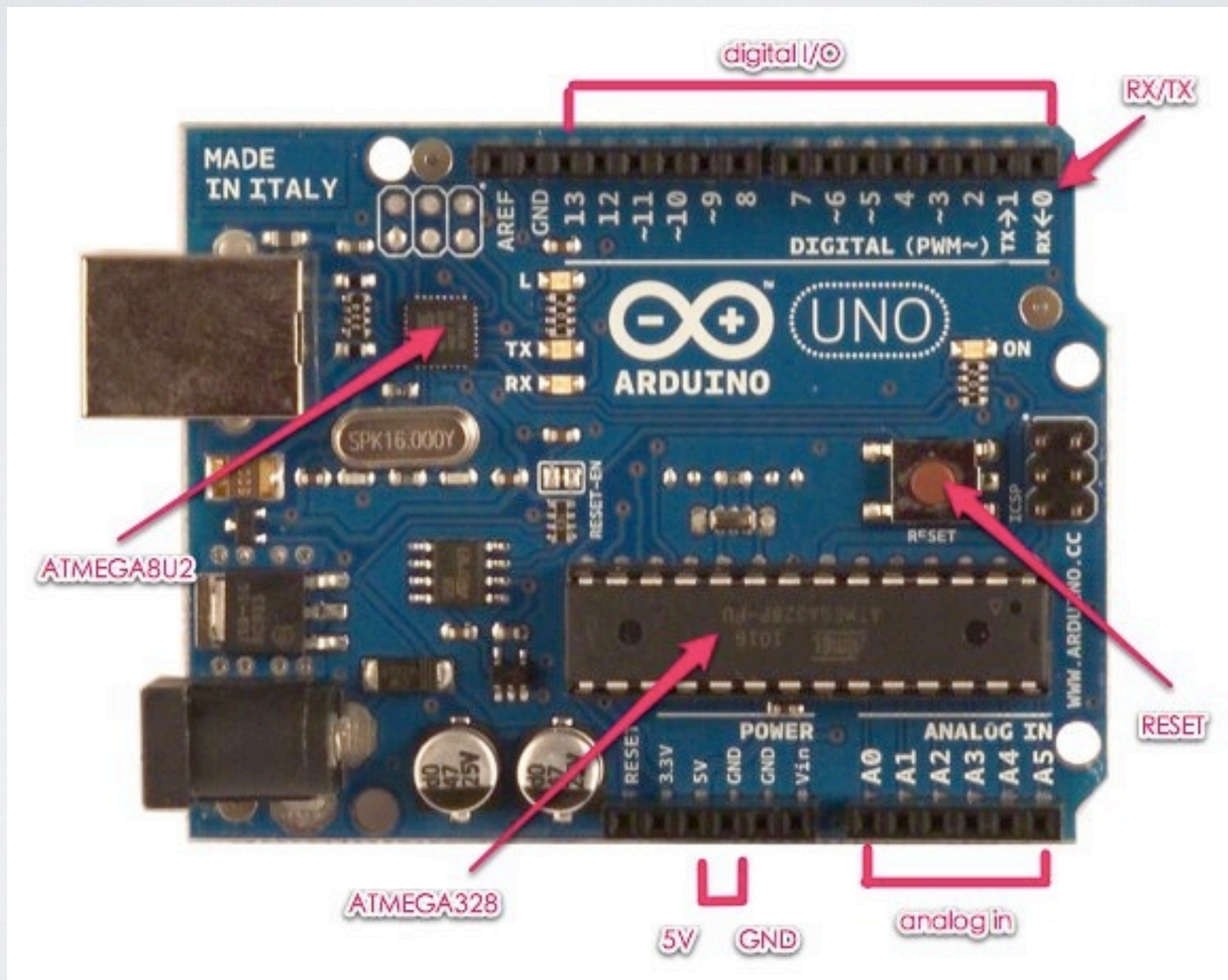


ARDUINO FEATURE

- Source電路圖設計 + 程式開發介面
- 免費下載，也可依需求自己修改!!
- Arduino 可使用ISCP線上燒入器，自我將新的IC晶片燒入bootloader
- 可依據官方電路圖，簡化Arduino模組，完成獨立運作的微處理控制
- 可簡單地與感測器，各式各樣的電子元件連接(EX：紅外線,超音波,熱敏電阻,光敏電阻,伺服馬達,...等)
- 支援多樣的互動程式 ex: Flash,Max/Msp,VVVV,PD,C,Processing... 等
- 使用低價格的微處理控制器(ATMEGA8/168/328) NT\$120~NT\$180
- USB介面，不需外接電源。另外有提供9VDC輸入

ARDUINO BOARD

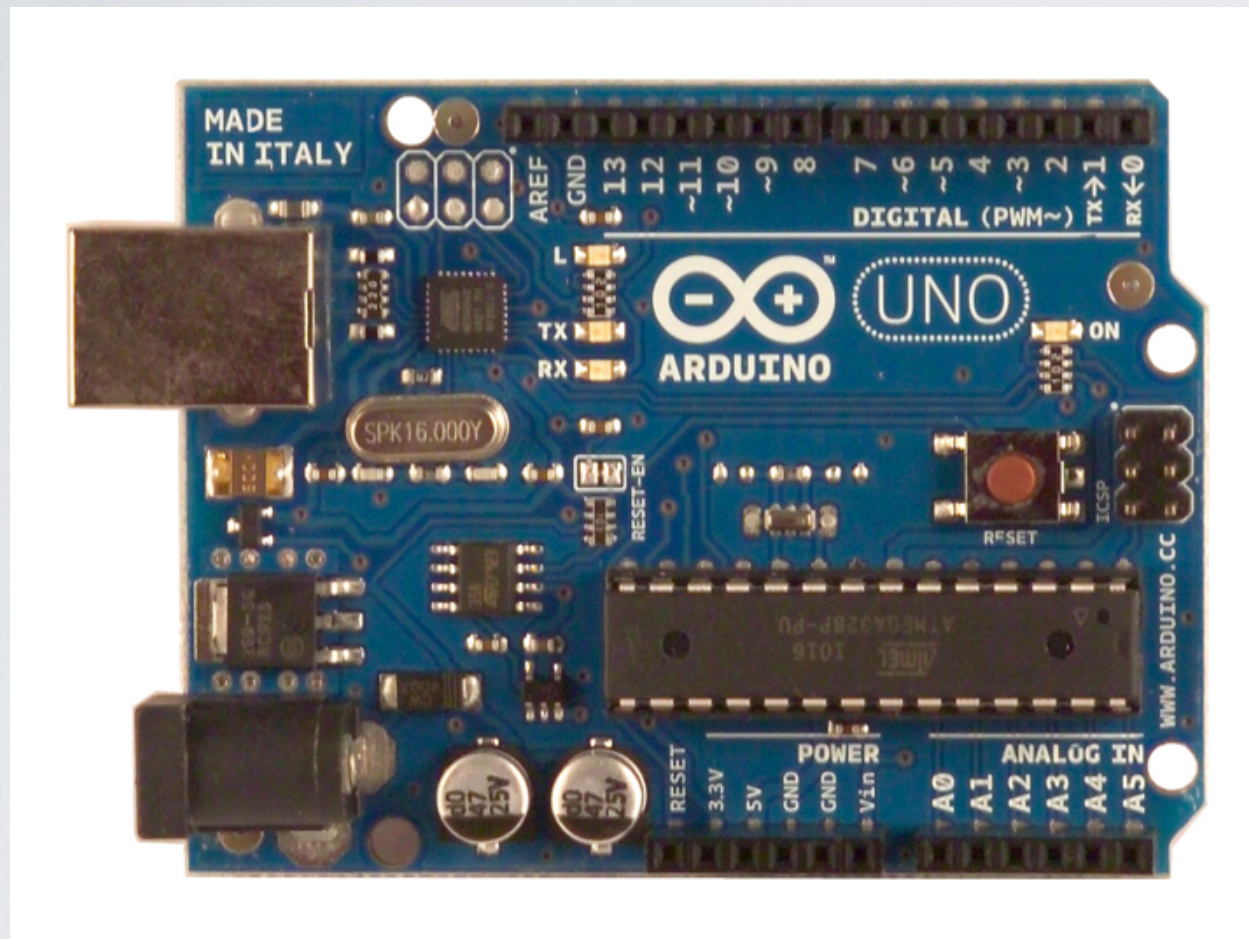
\$29.5



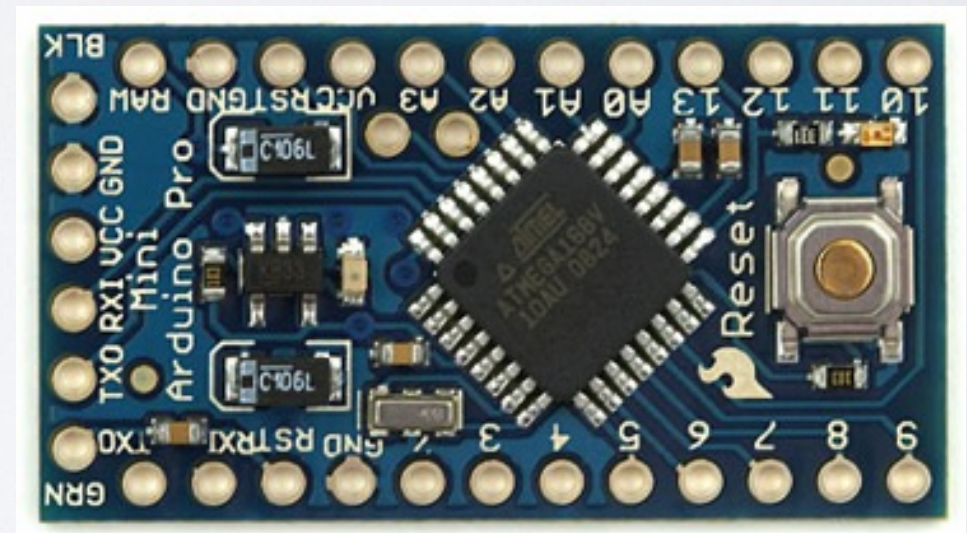
ARDUINO SPECIFICATION

- **Digital I/O** 數位式輸入/輸出端共 1~13
- Analog I/O 類比式輸入/輸出端共 0~5
- 支援USB接頭傳輸資料及供電(不需額外電源)
- 支援ICSP線上燒錄功能
- 支援TX/RX端子
- 支援AREF端子
- 支援3~6組PWM端子
- 輸入電壓：接上USB時無須供電，5V~12V DC輸入
- 輸出電壓：5V DC輸出

Arduino UNO



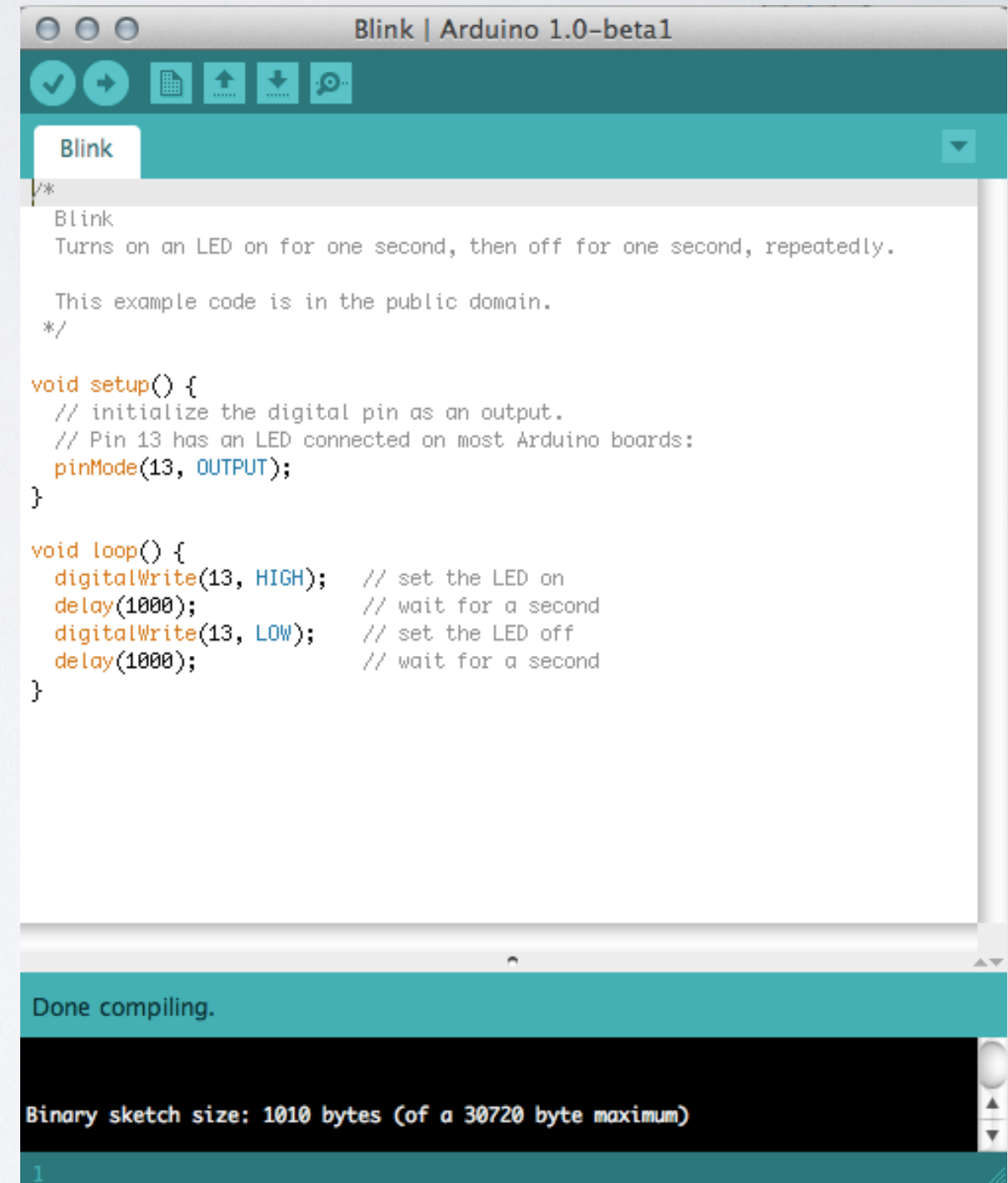
Arduino Pro Mini



33mm x 18mm

ARDUINO SOFTWARE

- Last Version: Arduino 1.0
- Windows
 - Xp, vista32/64, win7
- Mac
 - PPC, intel (MAC OS 10.7 Lion)
- Linux



The screenshot shows the Arduino IDE interface with the 'Blink' sketch loaded. The title bar reads 'Blink | Arduino 1.0-beta1'. The toolbar includes icons for checking, running, saving, opening, and uploading. The sketch name 'Blink' is displayed in the top left. The code editor contains the following text:

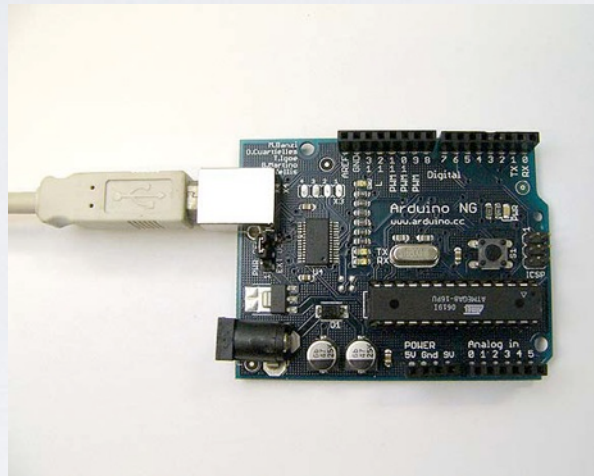
```
/*  
  Blink  
  Turns on an LED on for one second, then off for one second, repeatedly.  
  
  This example code is in the public domain.  
  */  
  
void setup() {  
  // initialize the digital pin as an output.  
  // Pin 13 has an LED connected on most Arduino boards:  
  pinMode(13, OUTPUT);  
}  
  
void loop() {  
  digitalWrite(13, HIGH); // set the LED on  
  delay(1000);            // wait for a second  
  digitalWrite(13, LOW);  // set the LED off  
  delay(1000);            // wait for a second  
}
```

At the bottom, a status bar indicates 'Done compiling.' and 'Binary sketch size: 1010 bytes (of a 30720 byte maximum)'. The line number '1' is shown in the bottom left corner.

下載ARDUINO

- 連上arduino.cc網站，下載Arduino IDE 1.0.x版本
- 安裝方式只需解壓縮到桌面即可，不需安裝任何東西
- 第一次接上USB到電腦需安裝Driver

安裝驅動

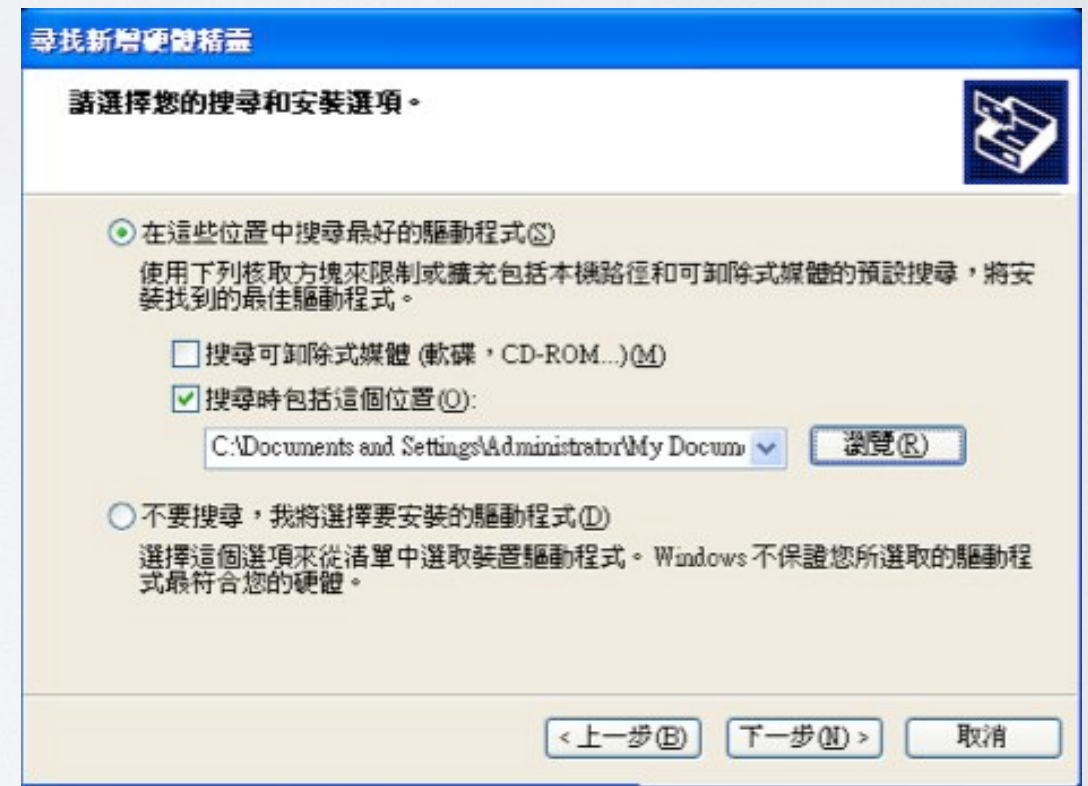
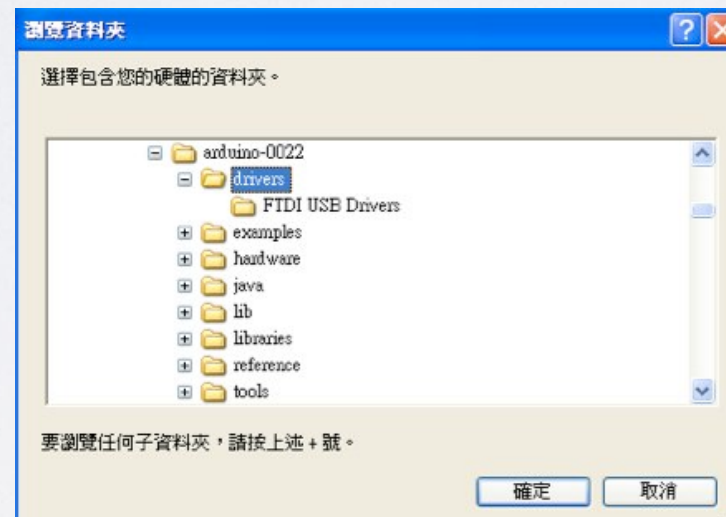


- 將Arduino接上方頭的USB線，另外一端連接電腦
- 接上之後會出現FTDI的驅動程式安裝畫面



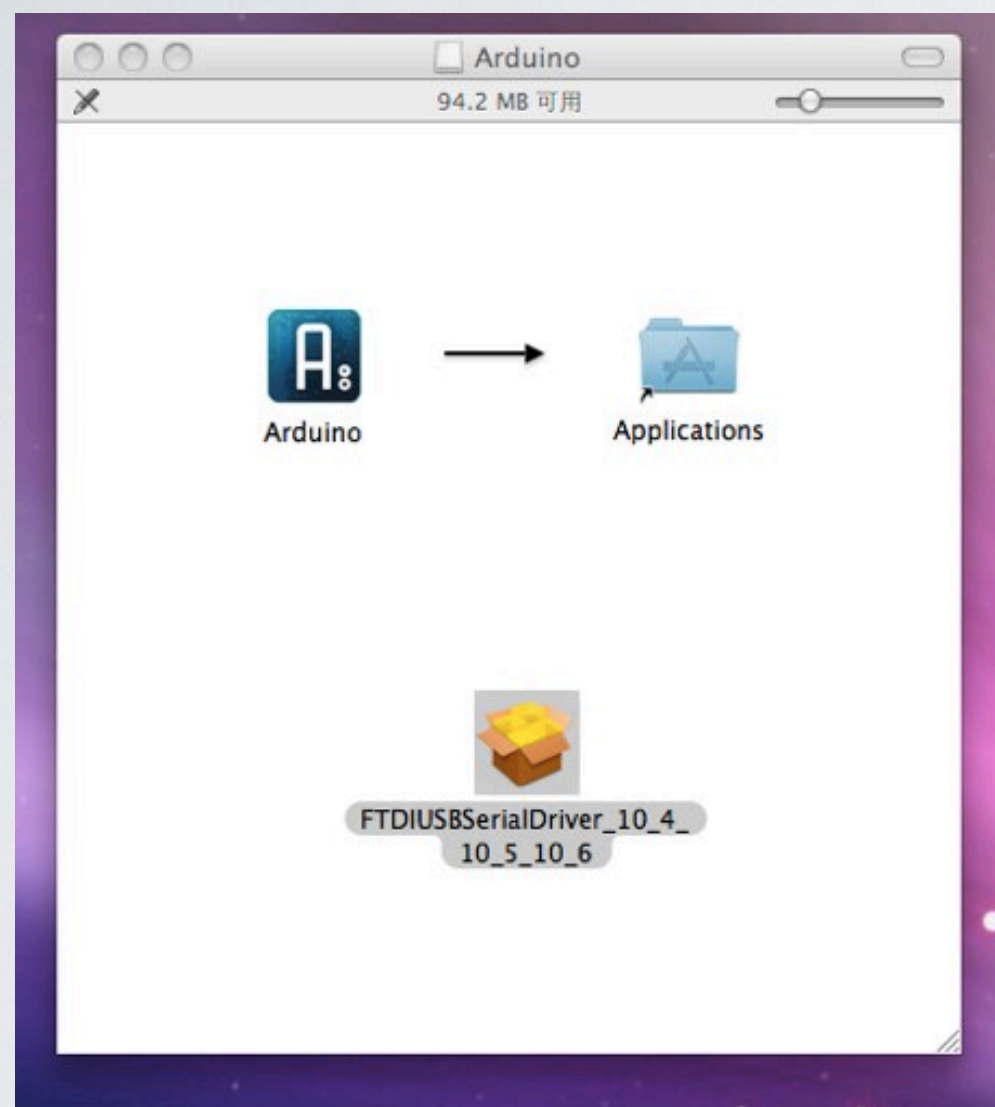
安裝驅動的位置

- 指定驅動程式安裝目錄，一般抓下來的arduino資料夾裡面就會包含 (EX:C:\arduino\drivers\)

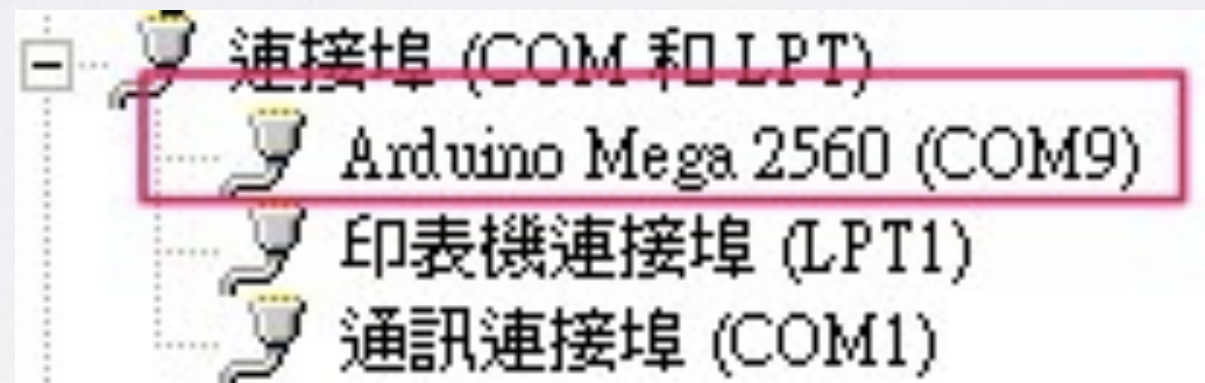




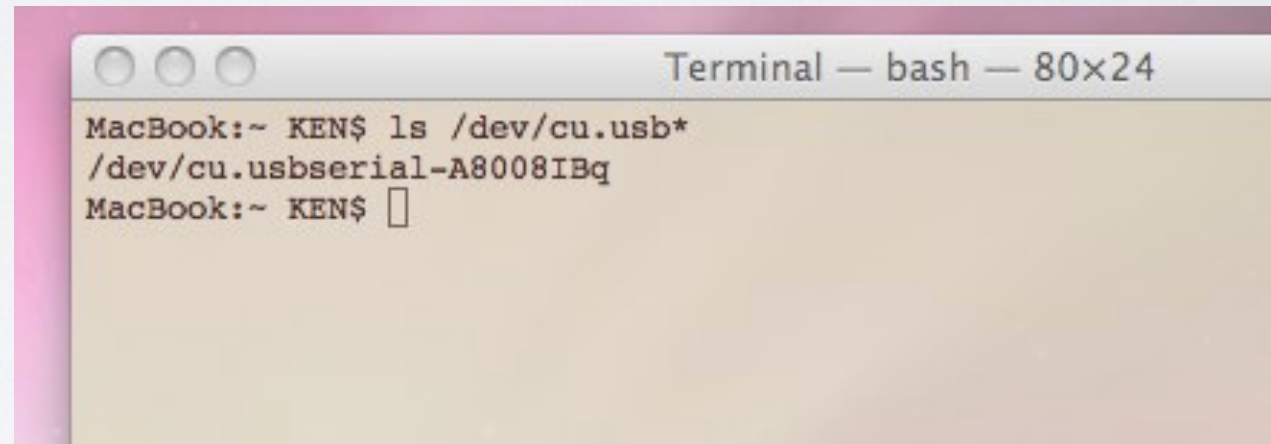
Arduino UNO



連接好硬體之後，可以先檢查一下你的Arduino是在哪個COM port。你可以打開(的電腦->控制台->系統->切換到“硬體”標籤->點選“裝置管理員”->展開連接埠(Com和LPT)->查看Arduino MEGA(UNO)(COM9)，括號裡面的數字就是你連接的Arduino Port)。

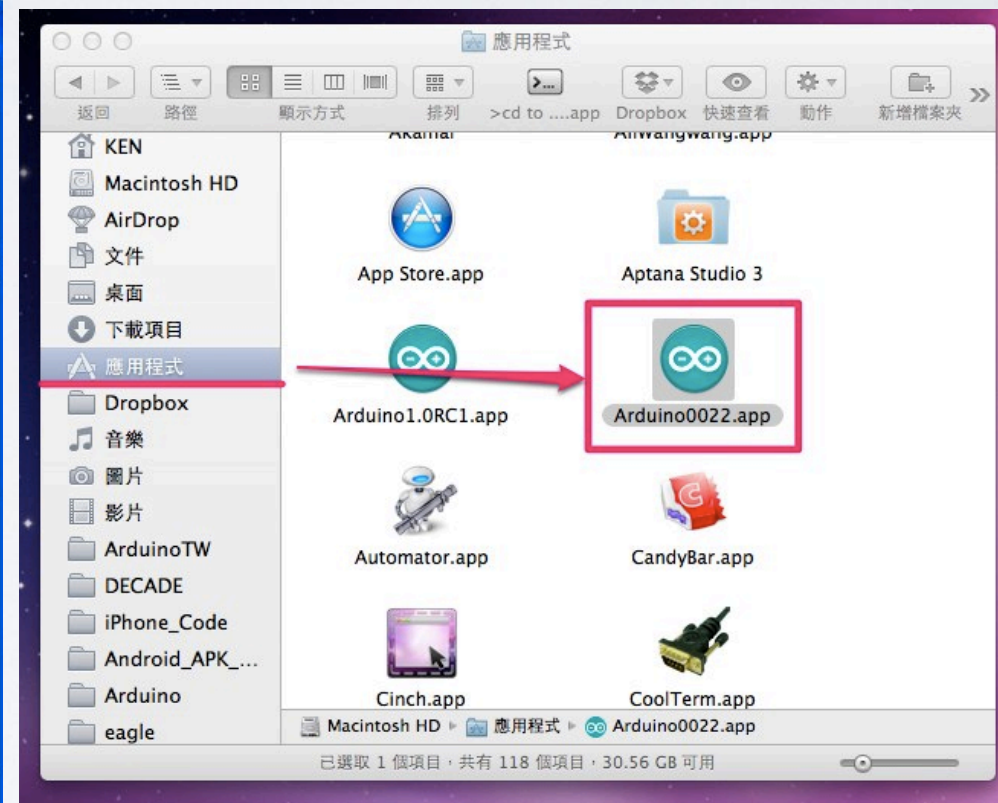
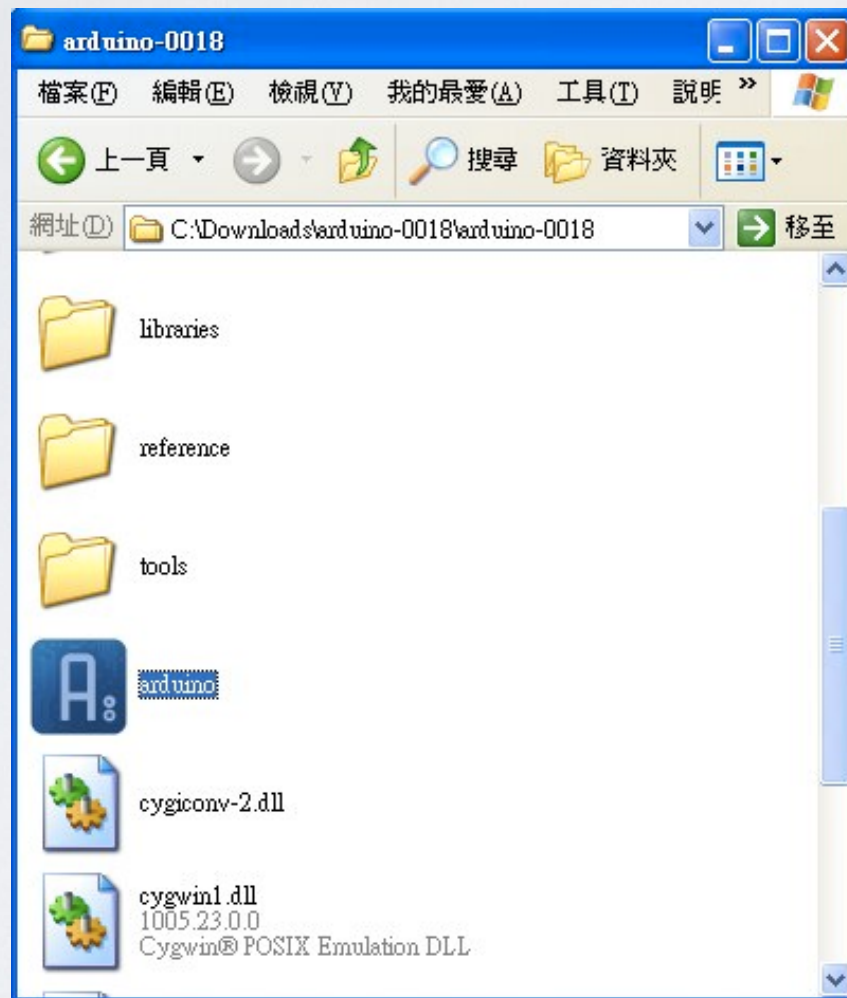


- 1.打開 工具程式->終端機
- 2.輸入 `ls /dev/cu.usb*`
- 3.按下enter
- 4.就會列出 `/dev/cu.usbserial-xxxxxxx` 就是您的usb COM PORT代號

A screenshot of a macOS Terminal window. The title bar at the top reads "Terminal — bash — 80x24". The window has three standard macOS window control buttons (red, yellow, green) on the left. The terminal content shows the prompt "MacBook:~ KEN\$" followed by the command "ls /dev/cu.usb*". The output of the command is "/dev/cu.usbserial-A8008IBq". Below the output, the prompt "MacBook:~ KEN\$" is shown again with a cursor (a small square) indicating the next input position.

```
MacBook:~ KEN$ ls /dev/cu.usb*  
/dev/cu.usbserial-A8008IBq  
MacBook:~ KEN$
```

啟動ARDUINO



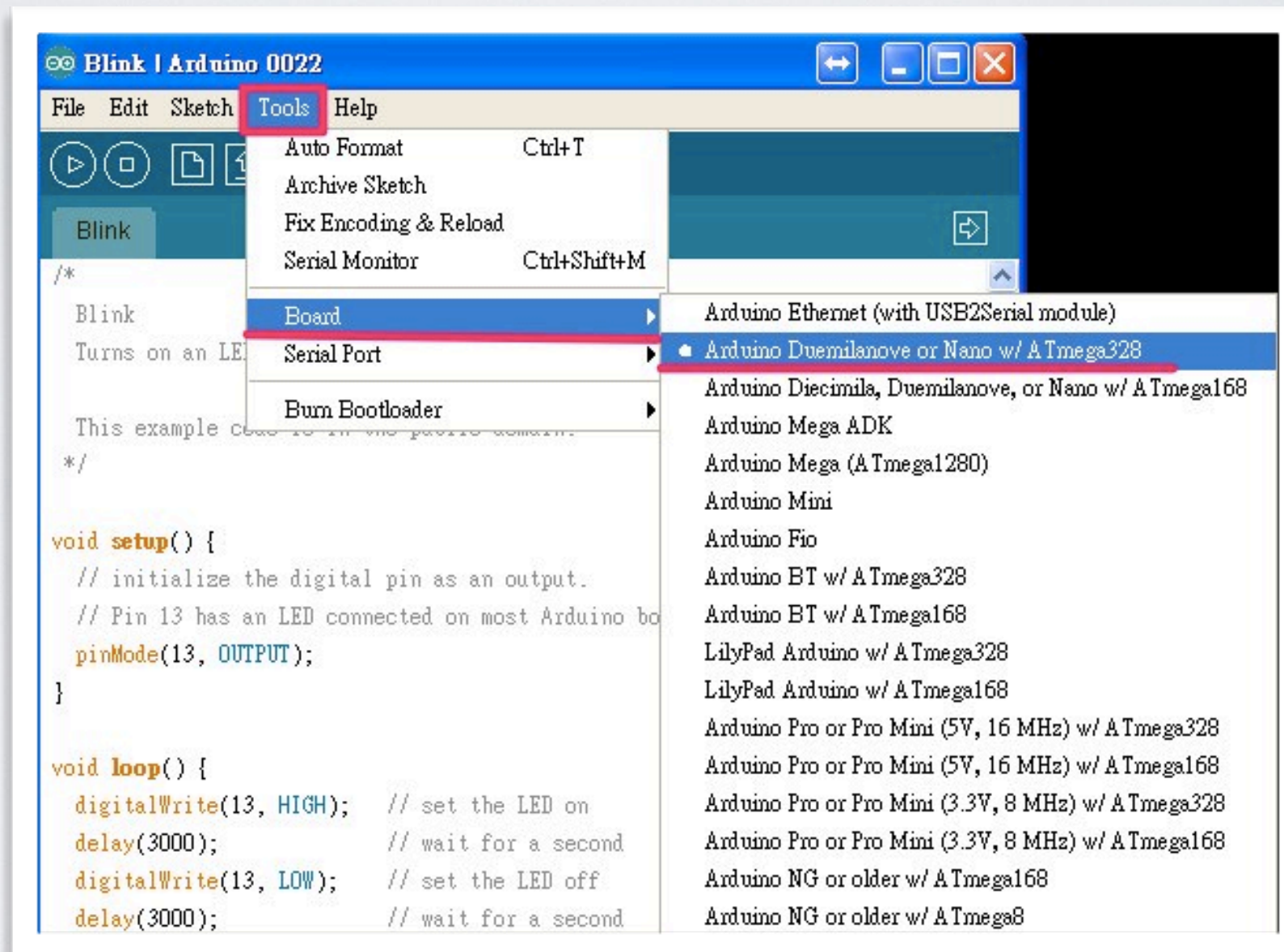
ARDUINO CODE

```
int ledPin = 13;

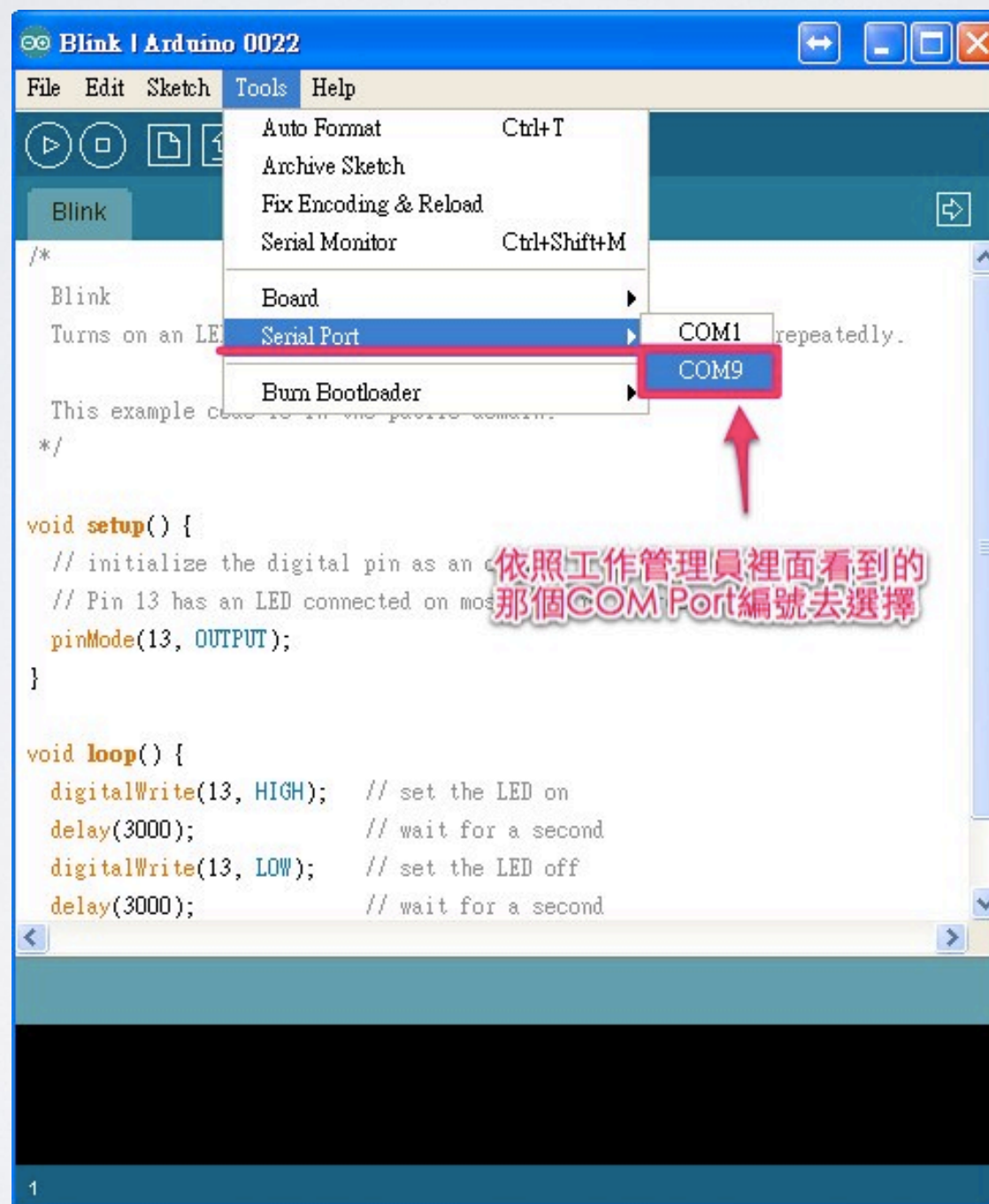
void setup()
{
    pinMode(ledPin, OUTPUT);
}

void loop()
{
    digitalWrite(ledPin, HIGH);
    delay(1000);
    digitalWrite(ledPin, LOW);
    delay(1000);
}
```

SELECT BOARD



SELECT PORT



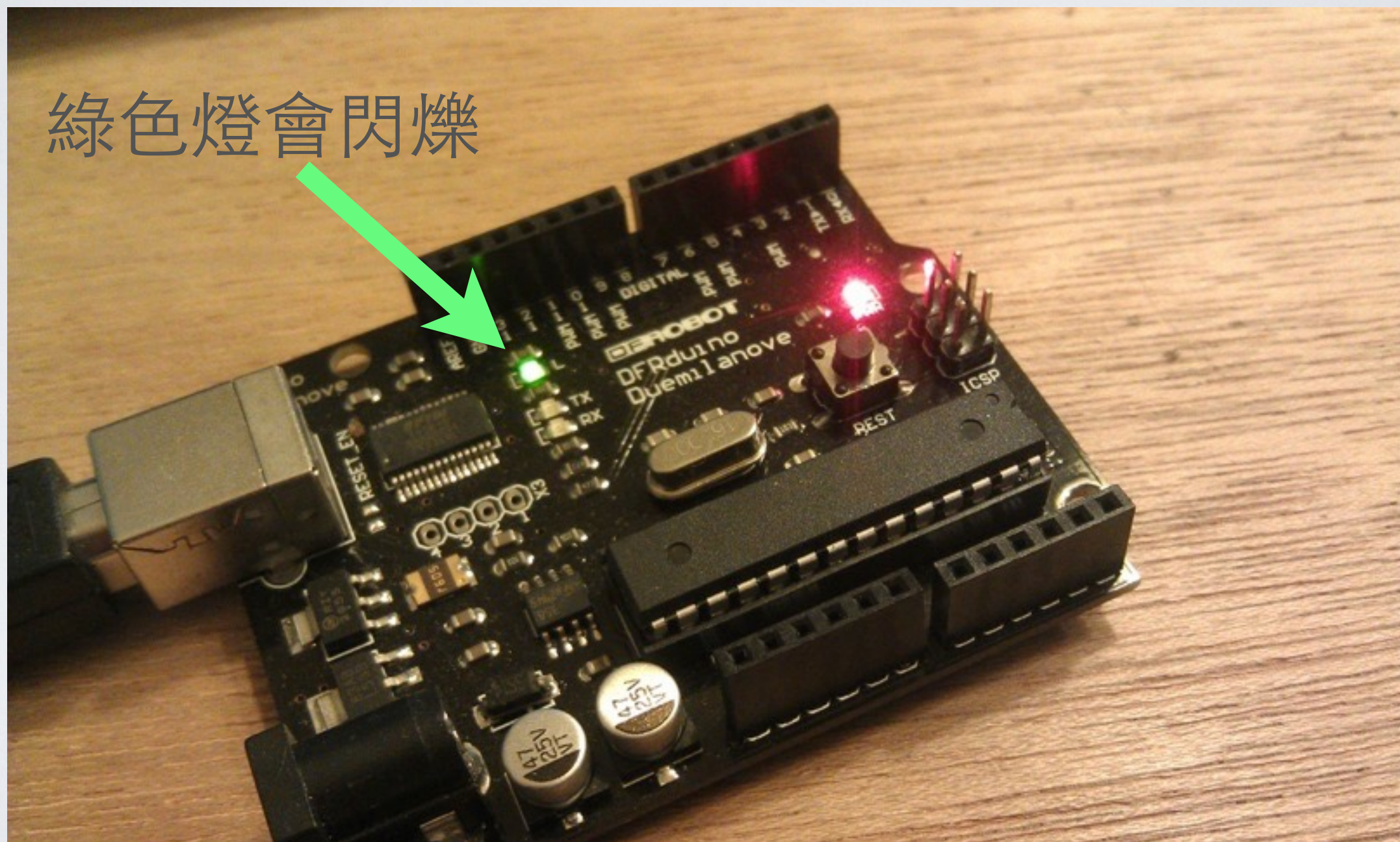
UPLOAD

- 按下軟體上面的Upload to I/O Board ，等待幾秒鐘，板子上的RX/TX燈號會連續閃爍，等閃爍之後，軟體上面的下面會出現：

```
Done uploading.  
Binary sketch size: 2574 bytes (of a 30720 byte maximum)  
8
```



COMPLETE



是怎麼運作的？

```
void setup()  
{
```

```
}
```

```
void loop()  
{  
  
}
```



當Arduino啟動時須設定的參數



當Arduino啟動後，會一直執行的工作


```
int ledPin = 13;  
void setup()  
{  
  
}  
void loop()  
{  
  
}
```

宣告一個ledPin的變數 = 13

```
int ledPin = 13;  
void setup()  
{  
    pinMode(ledPin, OUTPUT);  
}  
void loop()  
{  
  
}
```

設定某Pin腳為OUTPUT模式, 輸出模式
也有INPUT模式


```
int ledPin = 13;
void setup()
{
    pinMode(ledPin, OUTPUT);
}
void loop()
{
    digitalWrite(ledPin, HIGH);
    delay(1000);
}
```

設定PIN13腳位為高電位 = 5V 亮!!
設定延遲時間，1000 = 1秒 延遲

```
int ledPin = 13;
void setup()
{
    pinMode(ledPin, OUTPUT);
}
void loop()
{
    digitalWrite(ledPin, HIGH);
    delay(1000);
    digitalWrite(ledPin, LOW);
    delay(1000);
}
```

設定PIN13腳位為低電位 = 0V 滅!!
延遲