

# M1 ENJMIN – USMU03

## Bases de l'IHM

29 septembre 2021

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cubaud @ cnam.fr



le **cnam**  
Ecole nationale du jeu  
et des médias interactifs numériques **enjmin**

PDF du cours sur :

<https://cedric.cnam.fr/~cubaud/>

IHM = ?

Interface homme-machine

Interface humain-machine

Interaction humain-machine

Interaction humaine médiatisée



1968 : S. Kubrick "2001 l'odyssée de l'espace"

Exercice :  
nommer un logiciel sans IHM

Exercice :

calculer la proportion d'heures de formation  
à l'IHM par rapport au total d'une licence

# pub : association mondiale ACM SIGCHI



**SIGCHI Blog**

May 02, 2014  
SIGCHI 2014 Awards  
SIGCHI congratulates the 2014 award winners.

Apr 08, 2014  
SIGCHI Member Susan Dumais Named ACM "Athena Lecturer"

[More...](#)

**Quick Links**

[SIGCHI Conference Policies](#)

[SIGCHI Specialized Conferences policy](#)

[SIGCHI Policy for Compensation of CHI](#)

you are here: [home](#)

## Welcome

SIGCHI is the premier international society for professionals, academics and students who are interested in human-technology & human-computer interaction (HCI).

To get involved you can [join SIGCHI](#), join one of our [mailing lists](#), become a [volunteer](#), or visit your [local SIGCHI chapter](#).

ACM SIGCHI is the field of HCI gathering a large online community. There are two main ways to get involved:

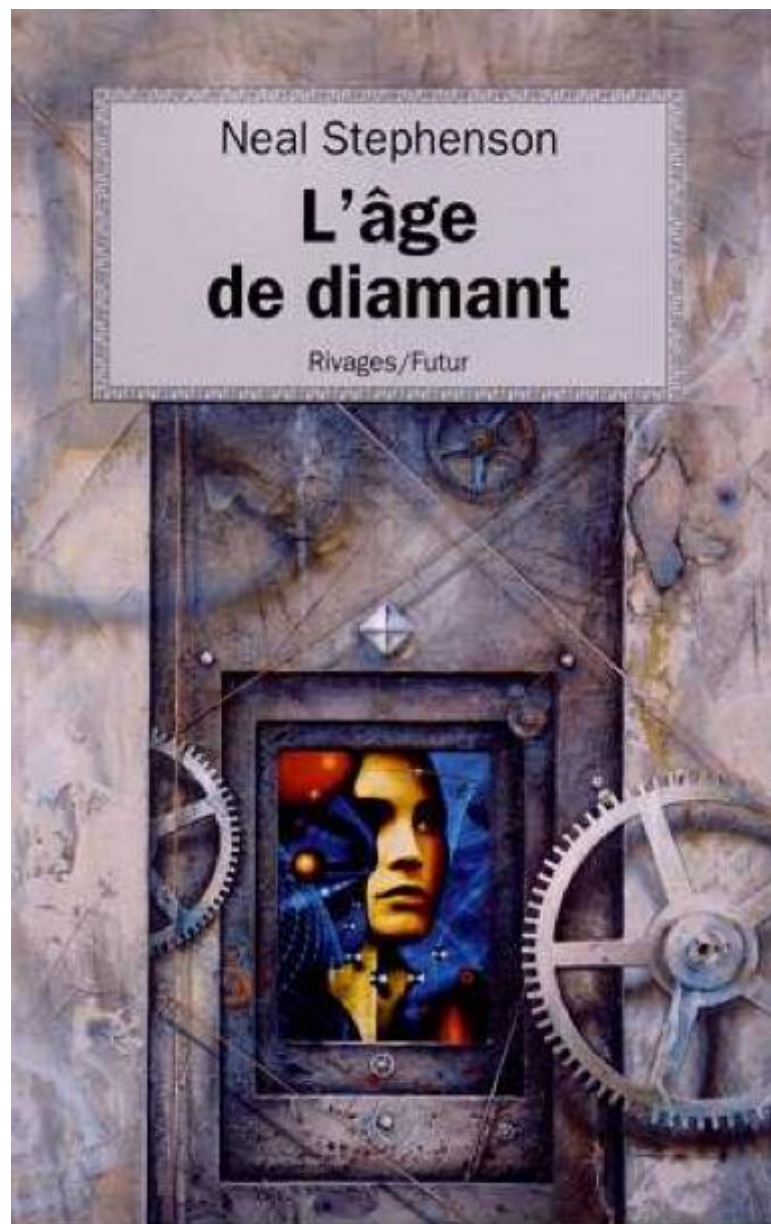
1. Please take time to participate in research. It should be fun and rewarding.
2. Volunteer to help and serving as a role model for passionate about HCI.



+ la revue



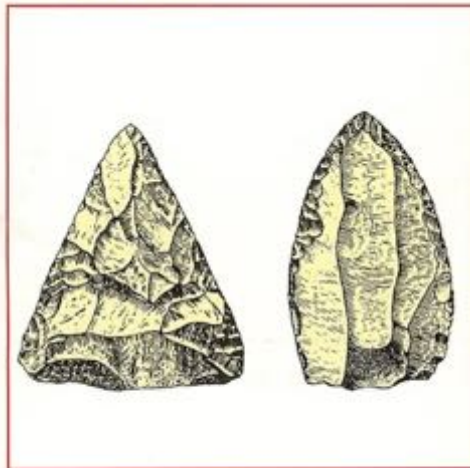
A (re)lire !



et aussi Leroi-Gourhan ?

# L'homme et la matière

André Leroi-Gourhan



Sciences d'aujourd'hui

Albin Michel

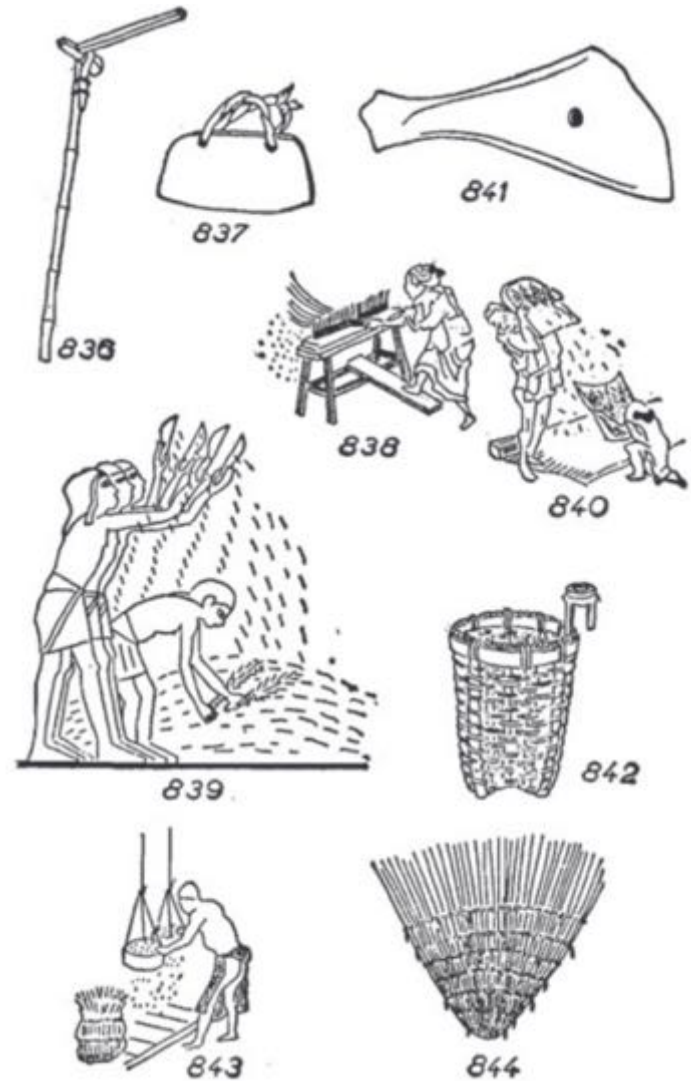
# Milieu et technique

André Leroi-Gourhan

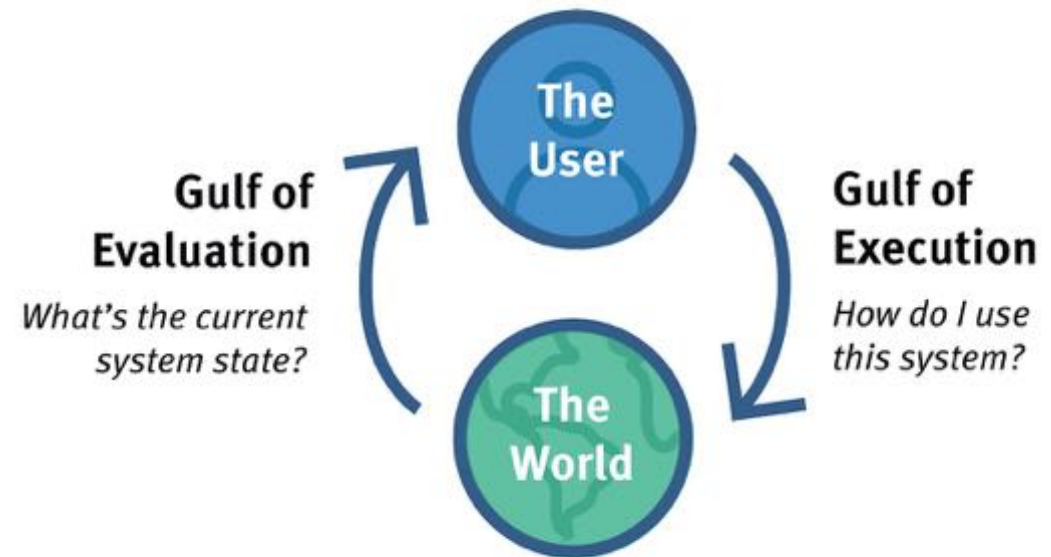
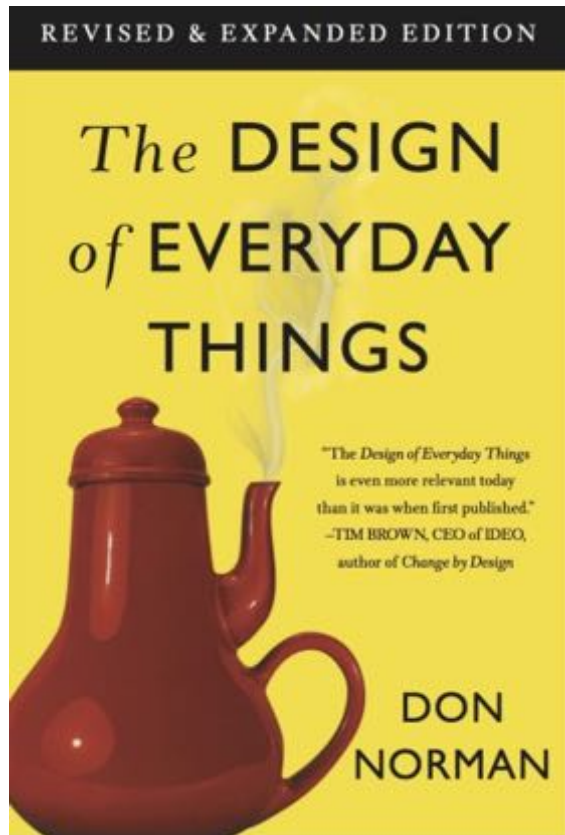


Sciences d'aujourd'hui

Albin Michel



# Don(ald) Norman (1988)



nngroup.com **NN/g**

<https://www.nngroup.com/articles/two-ux-gulfs-evaluation-execution/>



<http://jovermeulen.com/Research/FeedforwardCHI2013>

# Affordance

en design : capacité d'un objet à suggérer sa propre utilisation

**ÉDIA**  
édie libre

matiques  
sard

Wikipédia

à  
s récentes

ges liées  
n fichier  
ales  
ent  
sur la page  
idata  
age

## Affordance

Le terme d'**affordance** est emprunté à l'anglais et il est parfois traduit par « potentialité ». dérive du verbe *to afford* qui a un double sens : « être en mesure de faire quelque chose » et « offrir ».

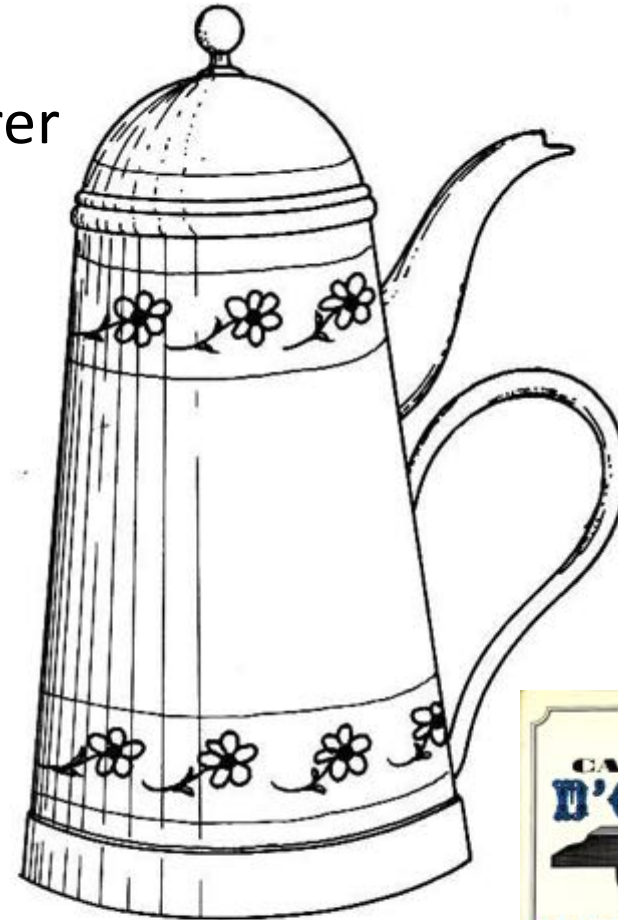
Le terme est utilisé dans différents champs, notamment la **psychologie cognitive**, la **psychologie de la perception**, la **psychologie ergonomique**, le **design**, l'**interaction homme machine** et l'**intelligence artificielle**, domaine où il prend une définition plus proche de « potentialité ».

Deux grandes voies de définition se sont développées :

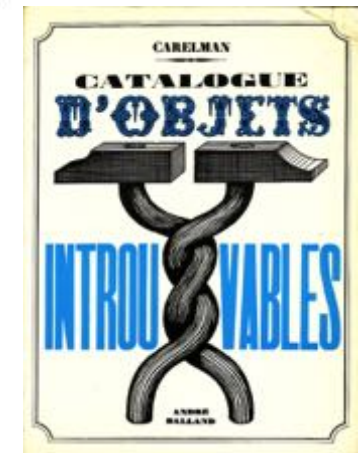
1. on doit à la **psychologie** la définition originale de l'affordance : elle désigne « toutes les possibilités d'actions sur un objet ». Cette définition s'est ensuite restreinte aux seules possibilités dont l'acteur est conscient ;
2. par la suite le terme a été utilisé en **ergonomie** de manière encore plus restreinte : pour se référer à la « capacité d'un objet à suggérer sa propre utilisation », par exemple, sans qu'il ne soit nécessaire de lire un mode d'emploi. On parle aussi d'utilisation intuitive (ou du caractère intuitif) d'un objet.

**Sommaire** [masquer]

- 1 Genèse
- 2 Affordance et perception



**E18 — Cafetière pour masochiste.**  
Nous pensons que le dessin est suffisamment explicite pour ne pas s'appesantir sur des détails qui pourraient s'avérer pénibles.



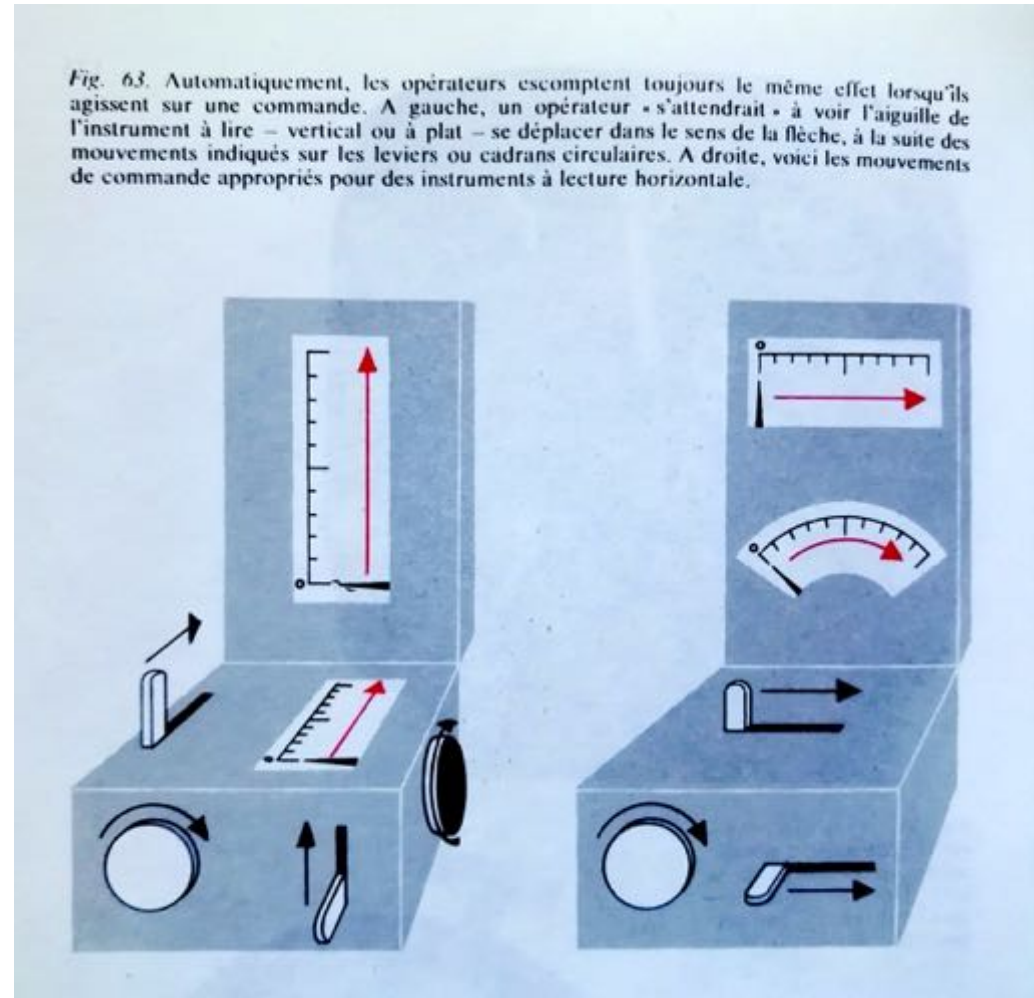
(lire l'article de Wikipedia)

repris dans D. Norman.  
The design of every day thing

# Rôle des conventions et du passé



Gros Horloge de Rouen  
(Wikipedia)



## Autre exemple : les pavés numériques



la touche 0 est en bas pour tous les dispositifs  
mais touches 123 en bas pour calculatrices  
en haut pour téléphones et télécommandes

photos : petit musée de P. Cubaud - d'après [Dix & Finlay]

## Nouveaux dispositifs : conventions contradictoires ?



Ma jolie cuisinière mixte



ELEC

GAZ

d'après B. Jacomy. L'age du plip. Seuil, 2002

Sketch de la télévision norvégienne :  
apparition du livre "volumen" comme remplaçant du rouleau



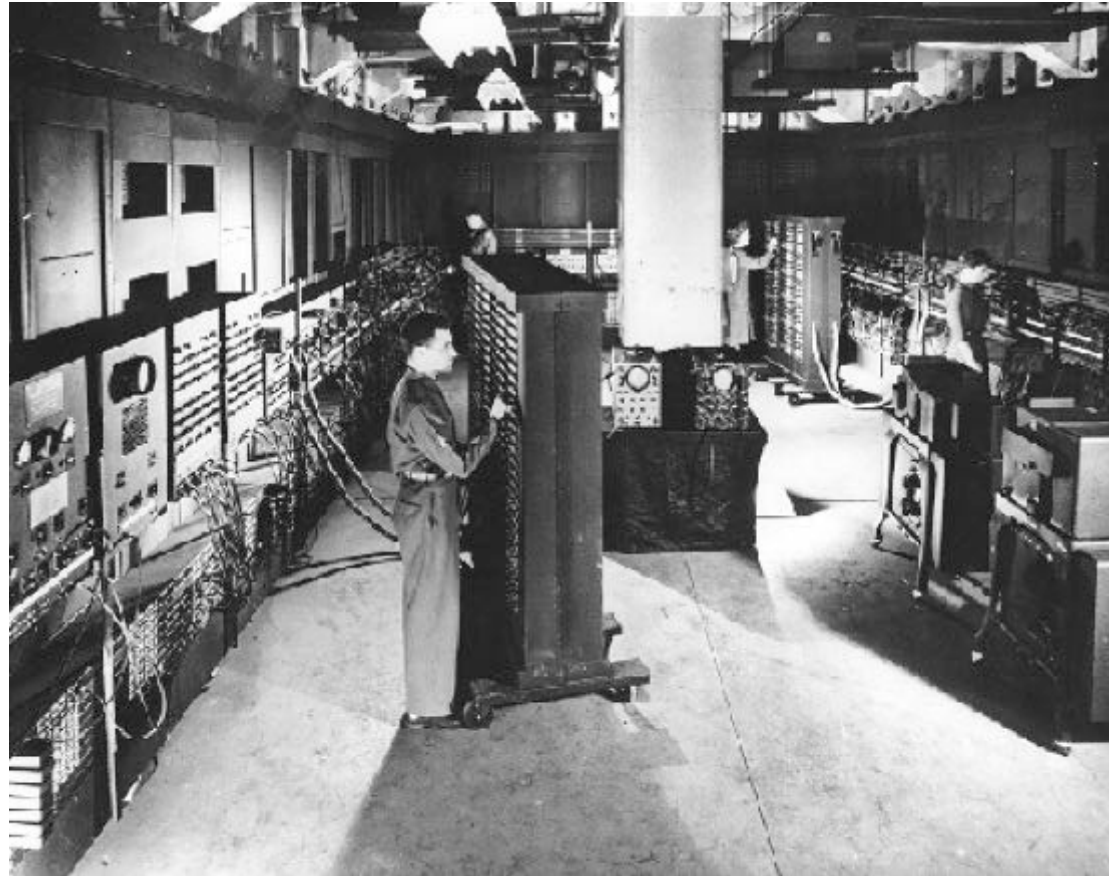
<https://youtu.be/cgcSxQiS0RM>



# **Suite de l'exposé :**

1. l'invention du WIMP
2. au-delà du WIMP
3. la captation
4. réalité étendue
5. objets malins

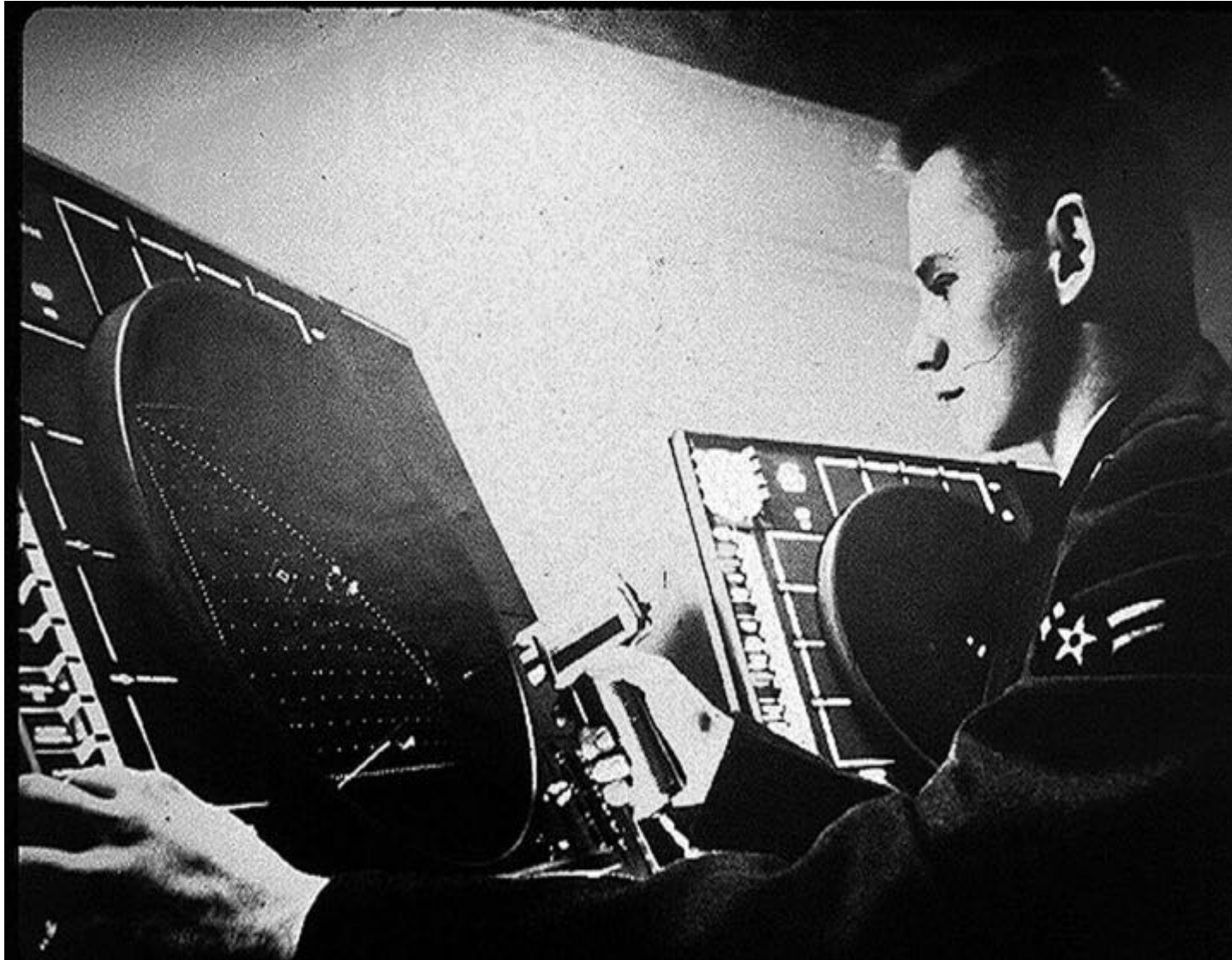
# (1) l'invention du WIMP



ENIAC - 1945

## Le temps-réel : projet Whirlwind MIT, 1950

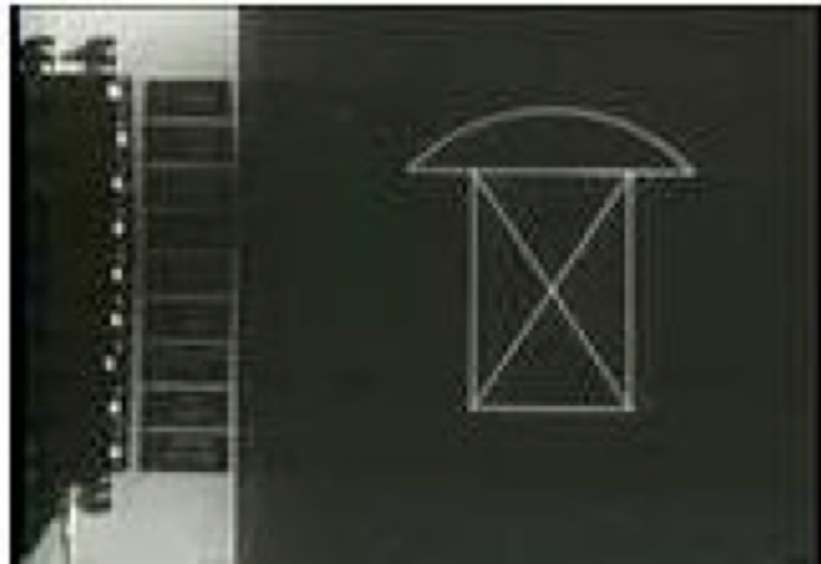
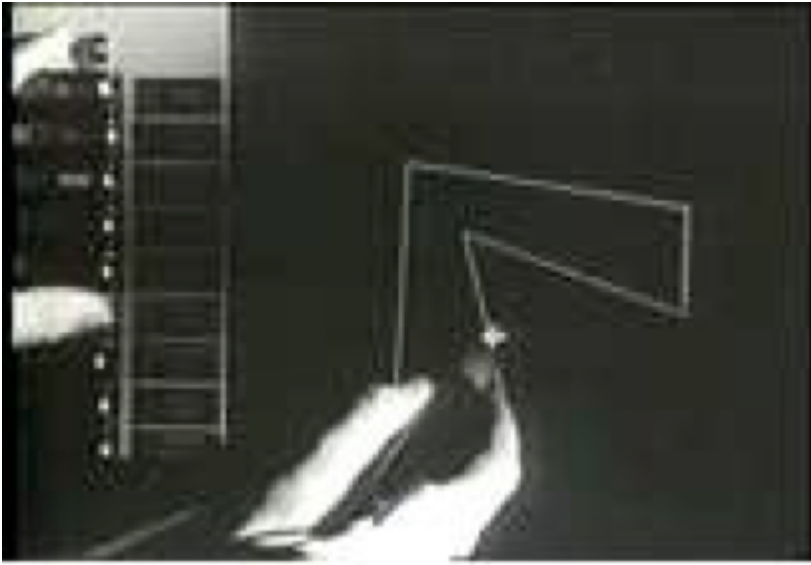




défense aérienne (SAGE)



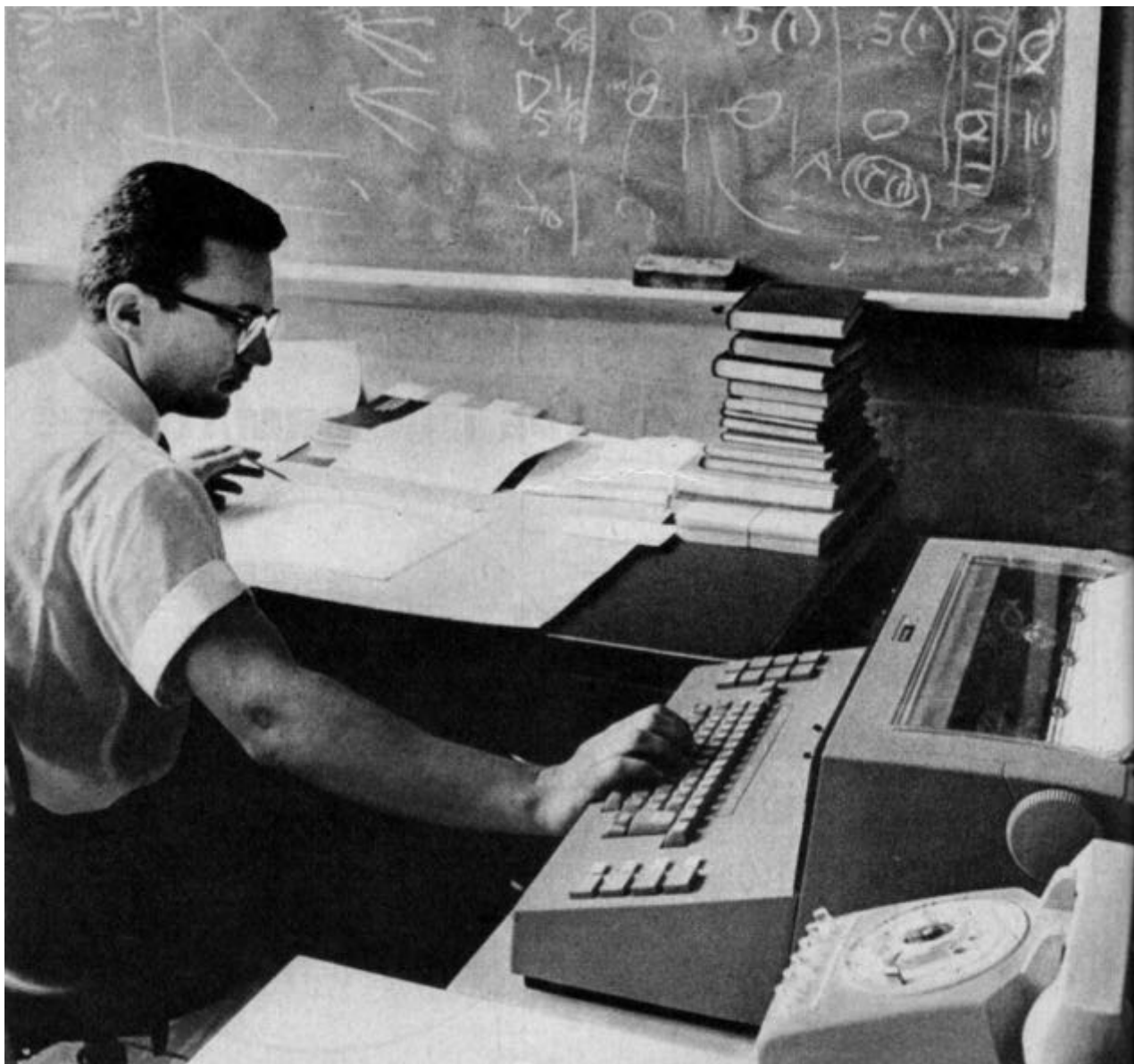
1961 : Ivan Sutherland sur TX1 (MIT)



**J.C.R. Licklider (1960)**  
**“man-computer symbiosis”**



“The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today.”



Le temps partagé (time sharing) :  
MIT, 1959-64





## **D. Engelbart : "augmenting human intellect" (SRI, 1963)**

"A Research Center for Augmenting Human Intellect," Douglas C. Engelbart, and William K. English, AFIPS Conference Proceedings of the 1968 Fall Joint Computer Conference, San Francisco, CA, December 1968, Vol. 33, pp. 395-410



Douglas Engelbart et sa souris de 1963 (Stanford), 40 ans après

```

Processes: 66 total, 2 running, 64 sleeping, 260 threads          11:15:01
Load Avg: 0.39, 0.21, 0.15  CPU usage: 2.39% user, 3.82% sys, 93.77% idle
SharedLibs: 8060K resident, 8192K data, 0B linkedit.
MemRegions: 7904 total, 347M resident, 24M private, 249M shared.
PhysMem: 502M wired, 586M active, 232M inactive, 1320M used, 2774M free.
VM: 152G vsize, 1040M framework vsize, 66915(0) pageins, 0(0) pageouts.
Networks: packets: 64/14K in, 64/14K out.
Disks: 15221/864M read, 3985/72M written.

PID  COMMAND      %CPU  TIME    #TH   #WQ   #POR  #MRE  RPRVT  RSHRD  RSIZE  VPRVT
203  fontd        0.0   00:00.12 3     1     78    91    2408K  540K   3356K  31M
202- mdworker32   0.0   00:00.86 3     1     53    114   2256K  14M    6716K  41M
201  top          5.9   00:02.41 1/1   0     26    33    872K   264K   1452K  18M
198  bash         0.0   00:00.01 1     0     17    24    356K   244K   1032K  17M
197  login        0.0   00:00.02 1     0     22    53    488K   244K   1596K  19M
187  Terminal     1.8   00:03.62 5     1    111   155-  7300K- 28M    18M-   35M-
186  mdworker     0.0   00:00.08 3     1     50    60    1500K  13M    3288K  31M
180  mdworker     0.0   00:00.70 3     1     48    60    1748K  13M    3828K  31M
170* LaunchCFMApp 0.1   00:02.25 5     0    104   278   10M    15M    17M    278M
169- Microsoft AU 0.0   00:00.05 2     1     63    67    724K   1184K  2012K  30M
168* pptfc       0.0   00:16.39 4     0    116   392   51M    18M    80M    432M
166* LaunchCFMApp 1.1   00:44.11 5     0    163   467   70M    38M    100M   481M
160  Safari       0.0   00:07.55 8     2    132   292   19M    27M    40M    175M
157  Preview      0.0   00:14.87 2     1    110   208   14M    34M    39M    41M

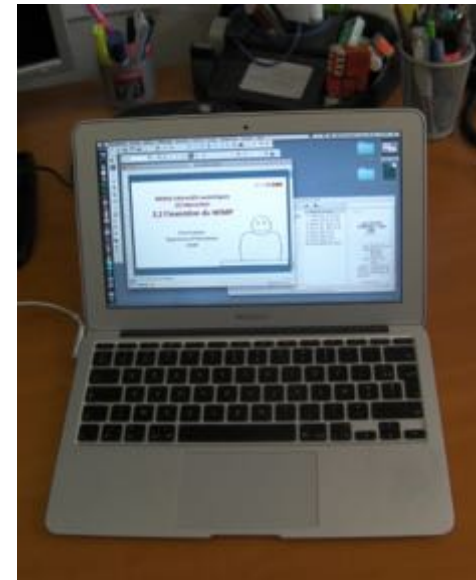
```

ecran type VT100 24 lignes \* 80 colonnes  
ici la commande UNIX top

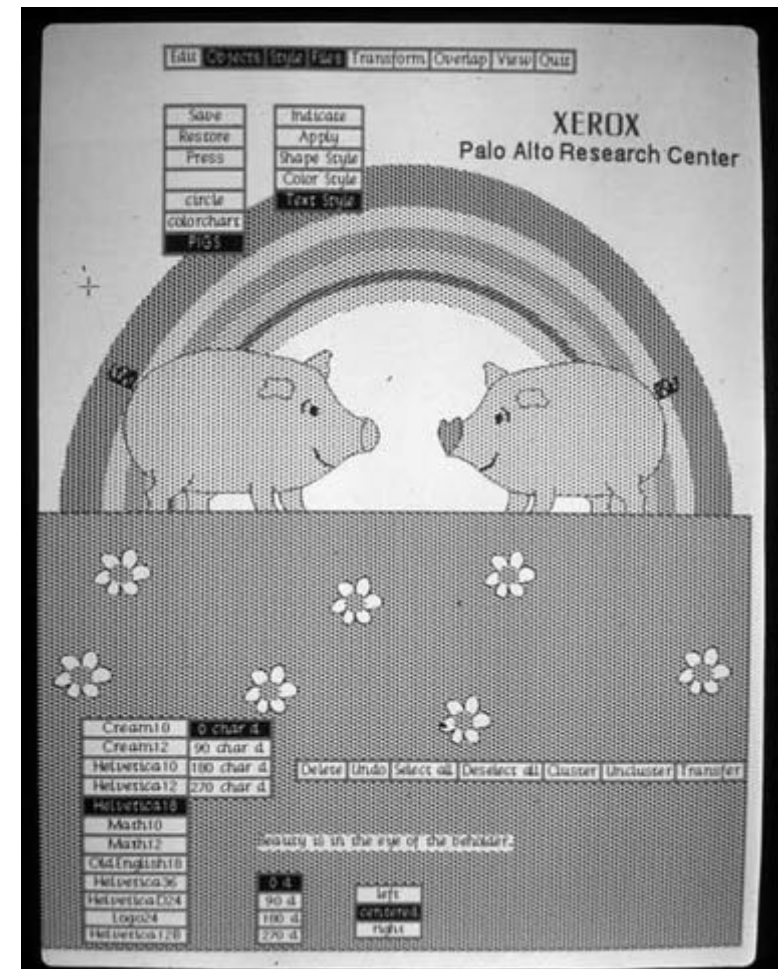
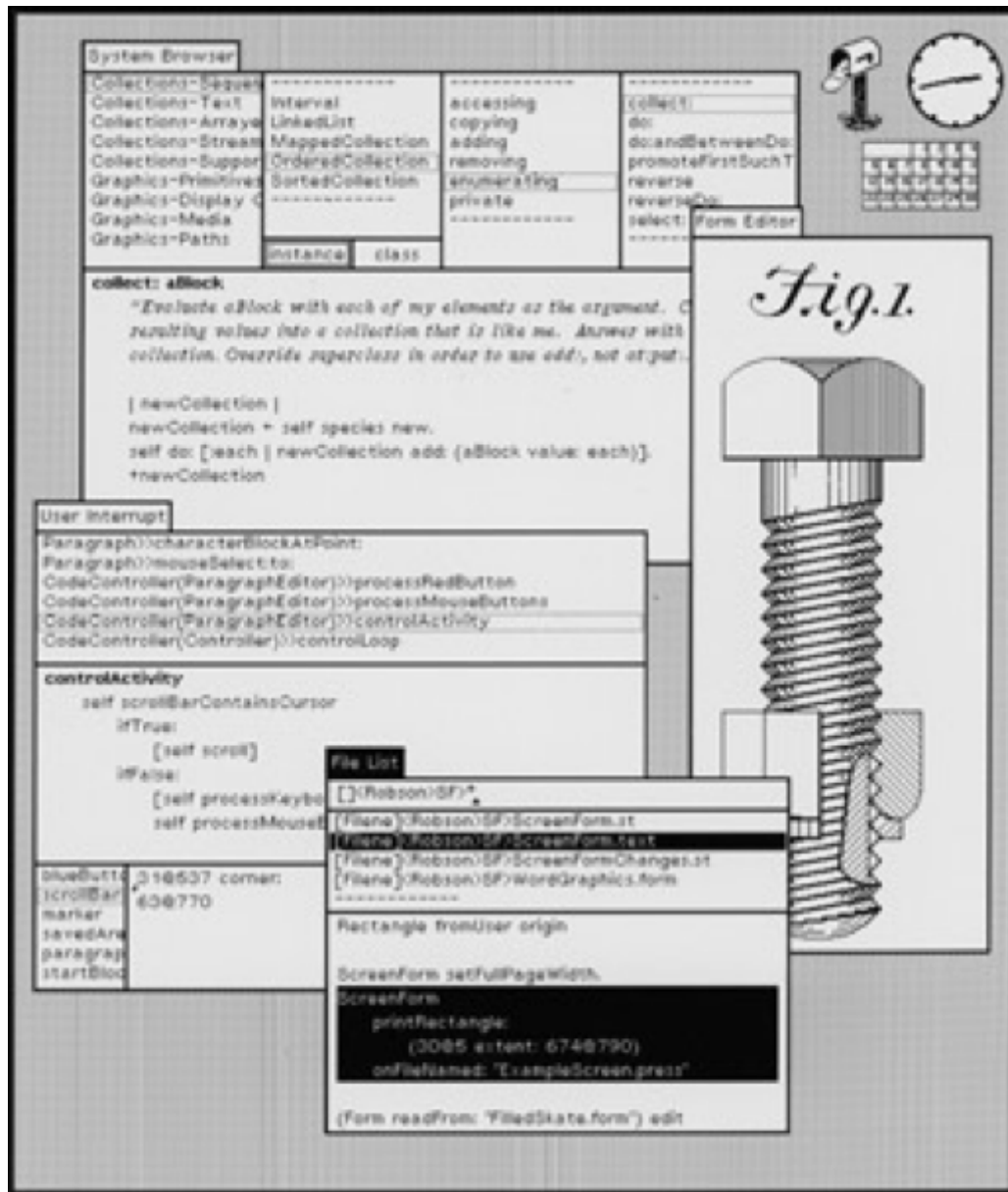
## 70's : XEROX PARC machine Alto :



- Ecran N&B 606 x 808 pixels (80 ppi)
- Clavier séparé, reconfigurable, mesure de force et durée
- Souris 3 boutons
- 2 disques durs de 3 Mo pour le stockage local
- Ethernet
- Imprimante laser



mon portable



<http://news.squeak.org/2007/12/29/old-smalltalk-pics-from-parc-place/>

À voir aussi :

<http://www.nomodes.com/tesler-resume.htm>

- "métaphore" du bureau (  desktop)

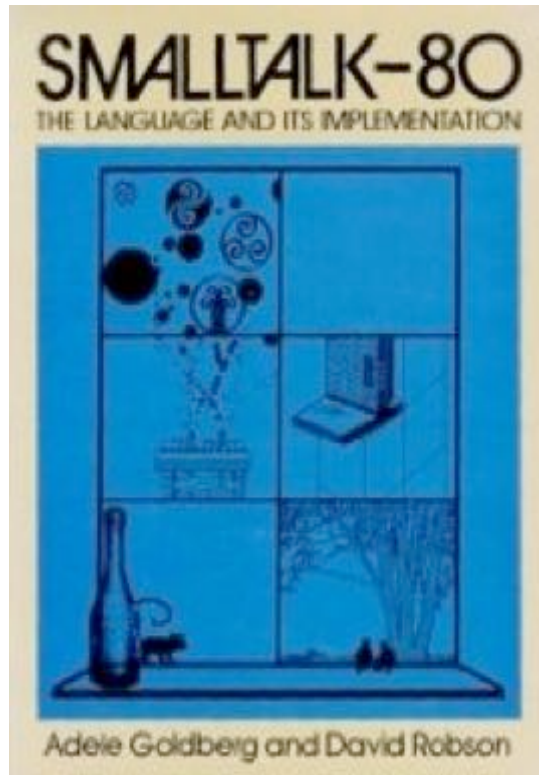
```
$  
$ rm -f toto.txt  
$ baud$
```



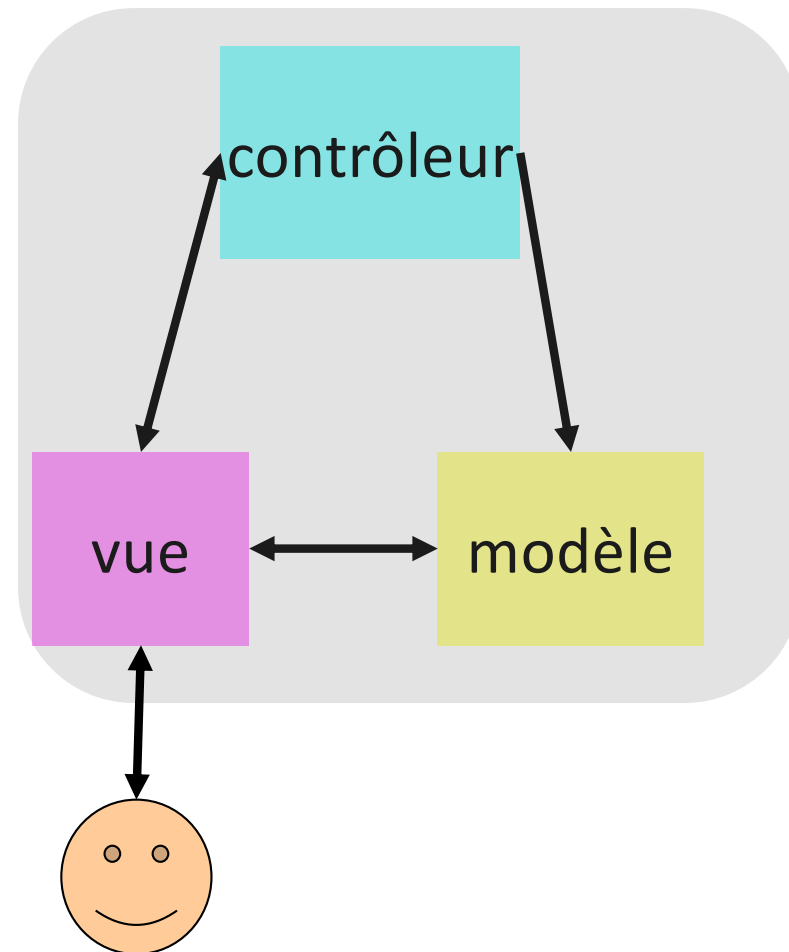
- le copier/coller (  copy/paste)
- l'annulation (  undo)

⇒ "manipulation directe" (Schneidermann, 1983) :  
des actions rapides, incrémentales, réversibles

- langage de programmation "objet"
- modèle MVC



(wikipedia)



# Larry Tesler

From Wikipedia, the free encyclopedia

**Lawrence Gordon Tesler** (April 24, 1945 – February 16, 2020) was an American [computer scientist](#) who worked in the field of [human–computer interaction](#). Tesler worked at [Xerox PARC](#), [Apple](#), [Amazon](#), and [Yahoo!](#)

While at PARC, Tesler's work included [Smalltalk](#), the first dynamic [object-oriented programming language](#), and [Gypsy](#), the first [word processor](#) with a [graphical user interface](#) (GUI) for the [Xerox Alto](#). During this, along with colleague Tim Mott, Tesler developed the idea of [copy and paste](#) functionality and the idea of [modeless](#) software. While at Apple, Tesler worked on the [Apple Lisa](#) and the [Apple Newton](#), and helped to develop [Object Pascal](#) and its use in application programming toolkits including [MacApp](#).

## Contents [\[hide\]](#)

- 1 [Biography](#)
  - 1.1 [Early career](#)
  - 1.2 [Xerox PARC](#)

**Larry Tesler**

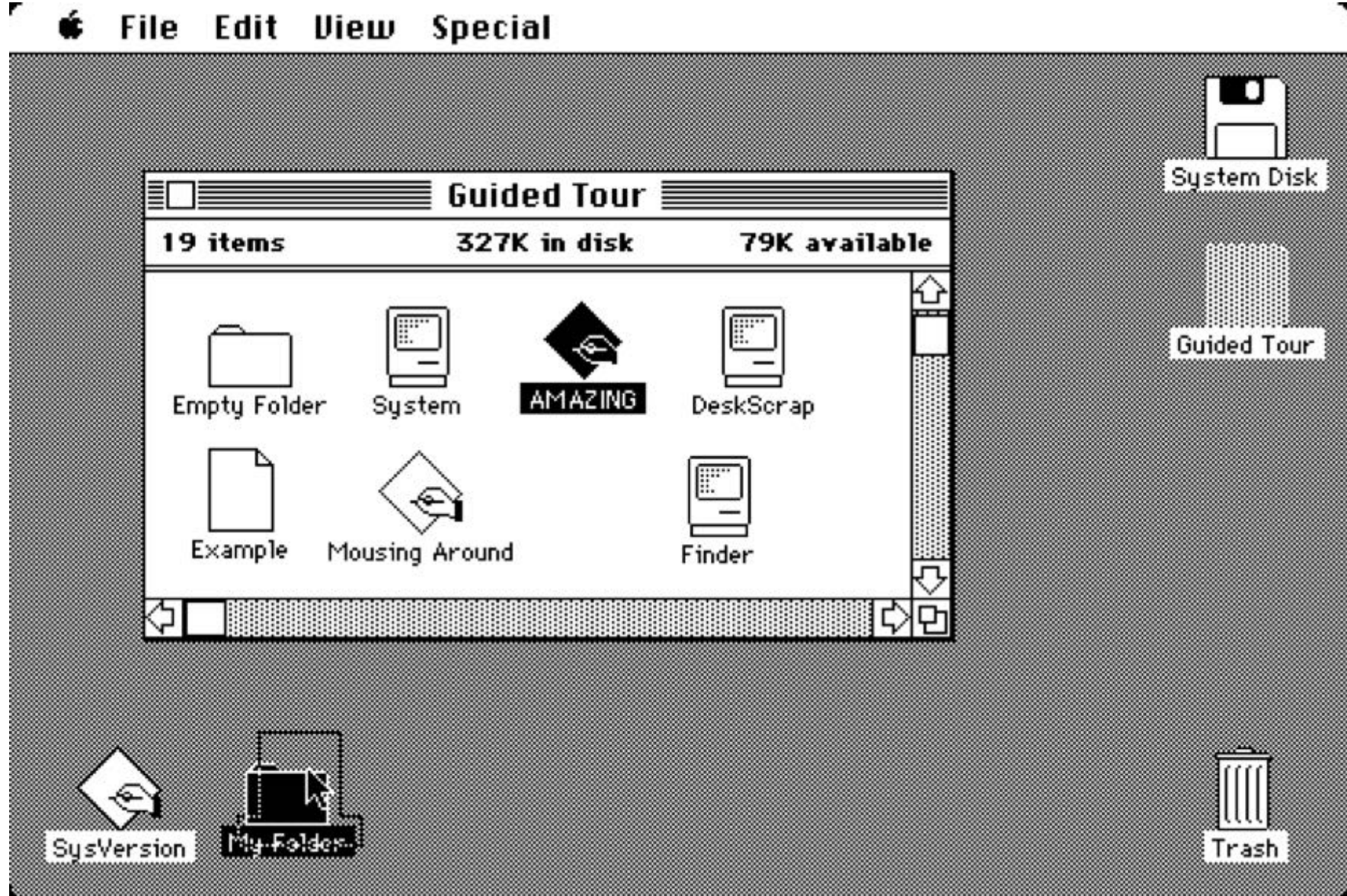


Tesler in 2007

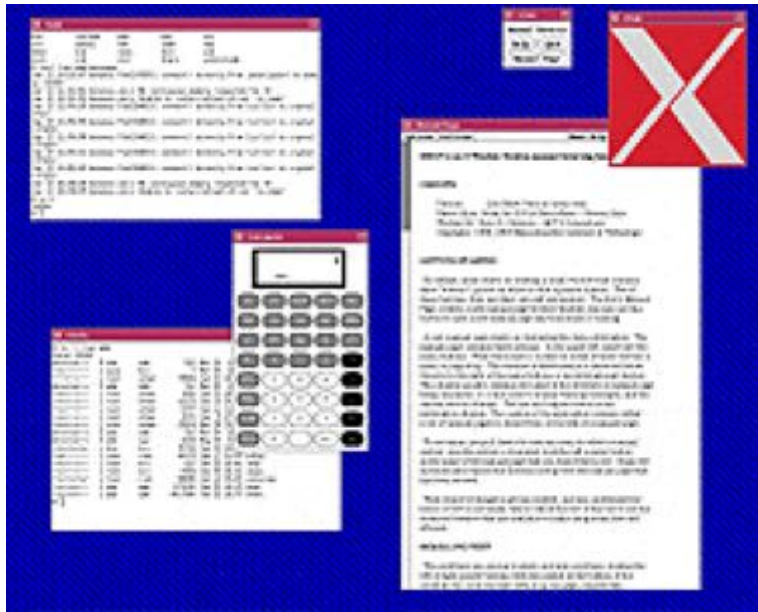
|                    |  |
|--------------------|--|
| <b>Born</b>        | Lawrence Gordon Tesler<br>April 24, 1945<br><a href="#">The Bronx, New York City, U.S.</a> |
| <b>Died</b>        | February 16, 2020 (aged 74)<br><a href="#">Portola Valley, California, U.S.</a>            |
| <b>Citizenship</b> | American   |
| <b>Alma mater</b>  | <a href="#">Stanford University</a>  |
| <b>Known for</b>   | <a href="#">Copy and paste</a>   |
| <b>Spouse(s)</b>   | unknown (div. 1969)<br>Colleen Barton (m. 1970)  |



# Apple : Macintosh (1/1984)



# X Window (X11.1 : 9/1987)

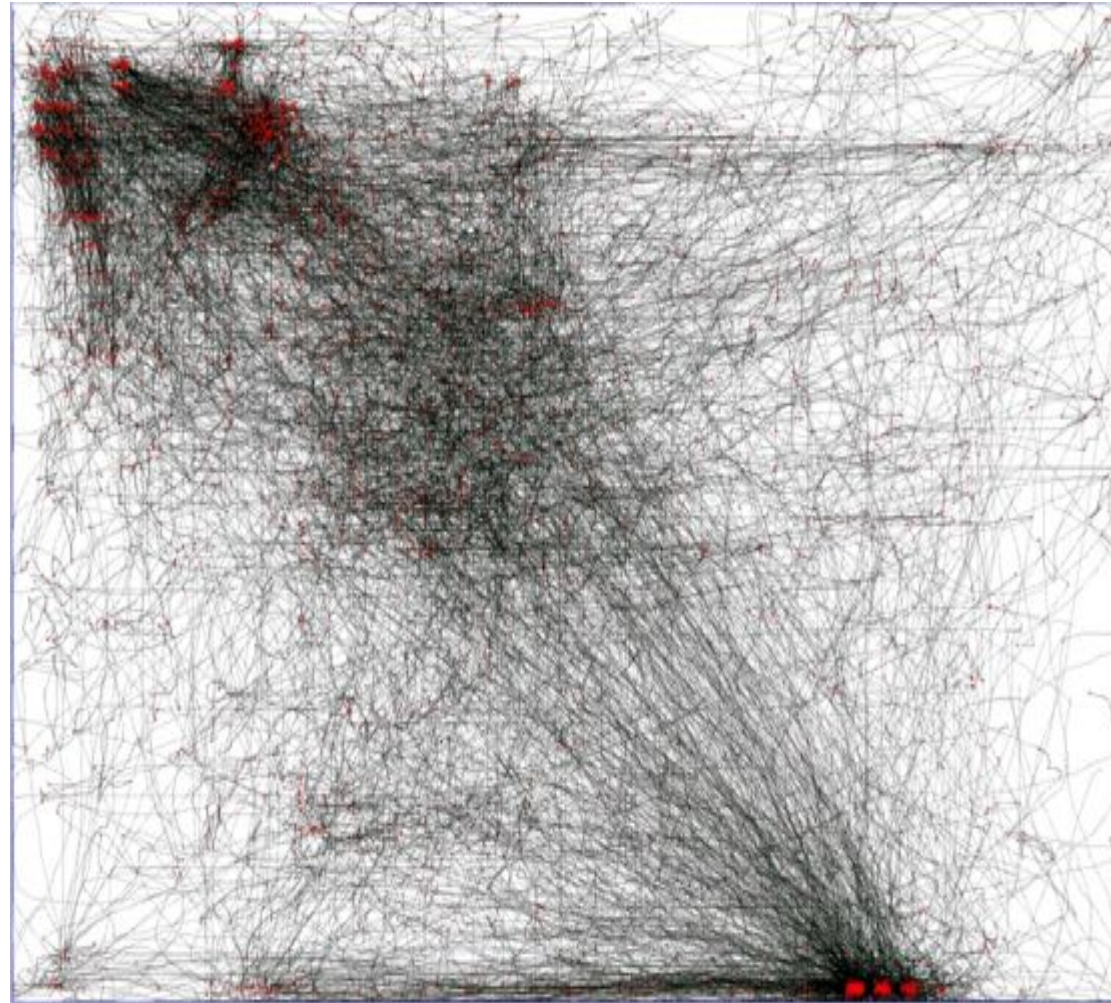


# NeXTSTEP (0.8 : 10/1988)



# Apple Aqua (1/2000)

## IHM vu du côté ordinateur...



O. Chapuis, R. Blanch, M. Beaudouin-Lafon  
Fitts' Law in the Wild: A Field Study of Aimed Movements  
LRI tech. report 1480, dec. 2007

## **(2) Au-delà du WIMP**



# 1 : A coût égal, croissance exponentielle de puissance



ma TI-57 (1980) et mon téléphone (2010)

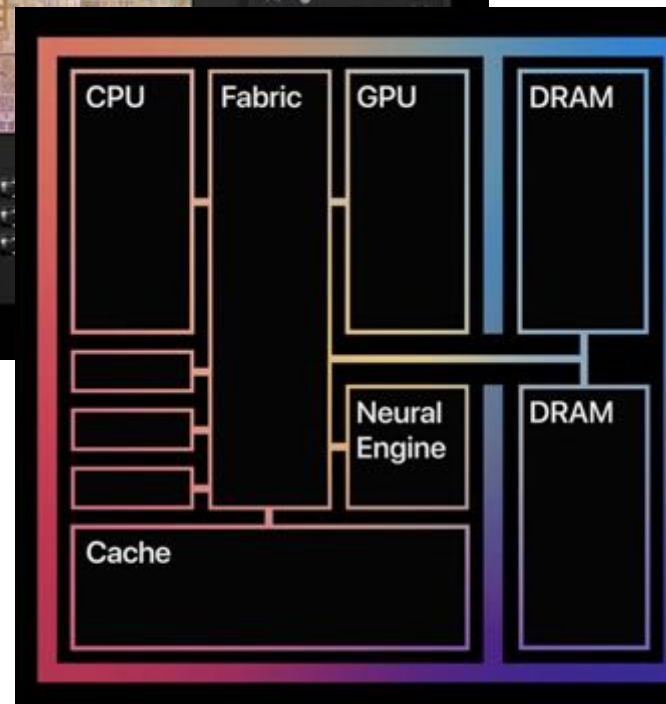
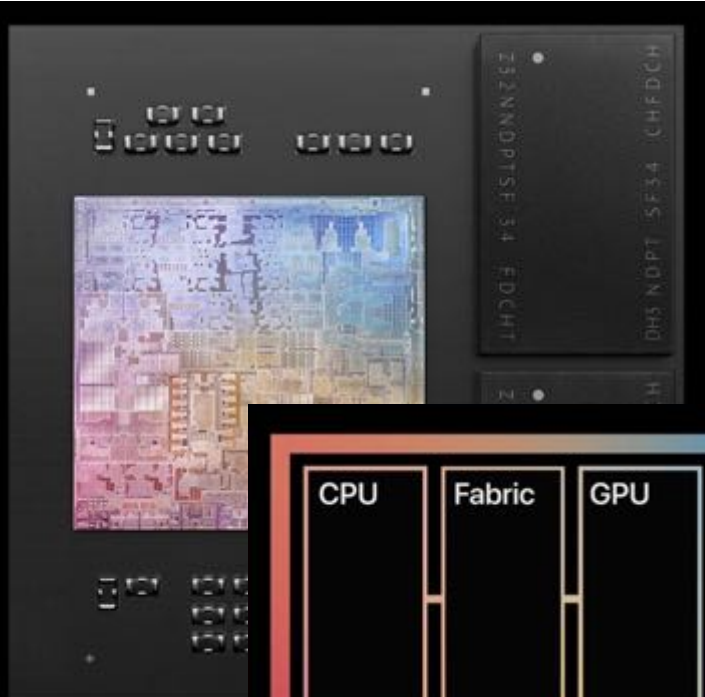
## Exemple : puce Apple M1 (fin 2020)

### Procédé de gravure en 5 nanomètres

La première puce d'ordinateur personnel élaborée avec cette technologie de pointe.

### 16 milliards de transistors

Le plus grand nombre de transistors que nous ayons jamais intégrés à une même puce.



Traitement vidéo  
Jusqu'à  
**3,9x**  
plus rapide<sup>1</sup>

Traitement d'images  
Jusqu'à  
**7,1x**  
plus rapide<sup>2</sup>

## 2: à puissance égale, décroissance exponentielle du coût





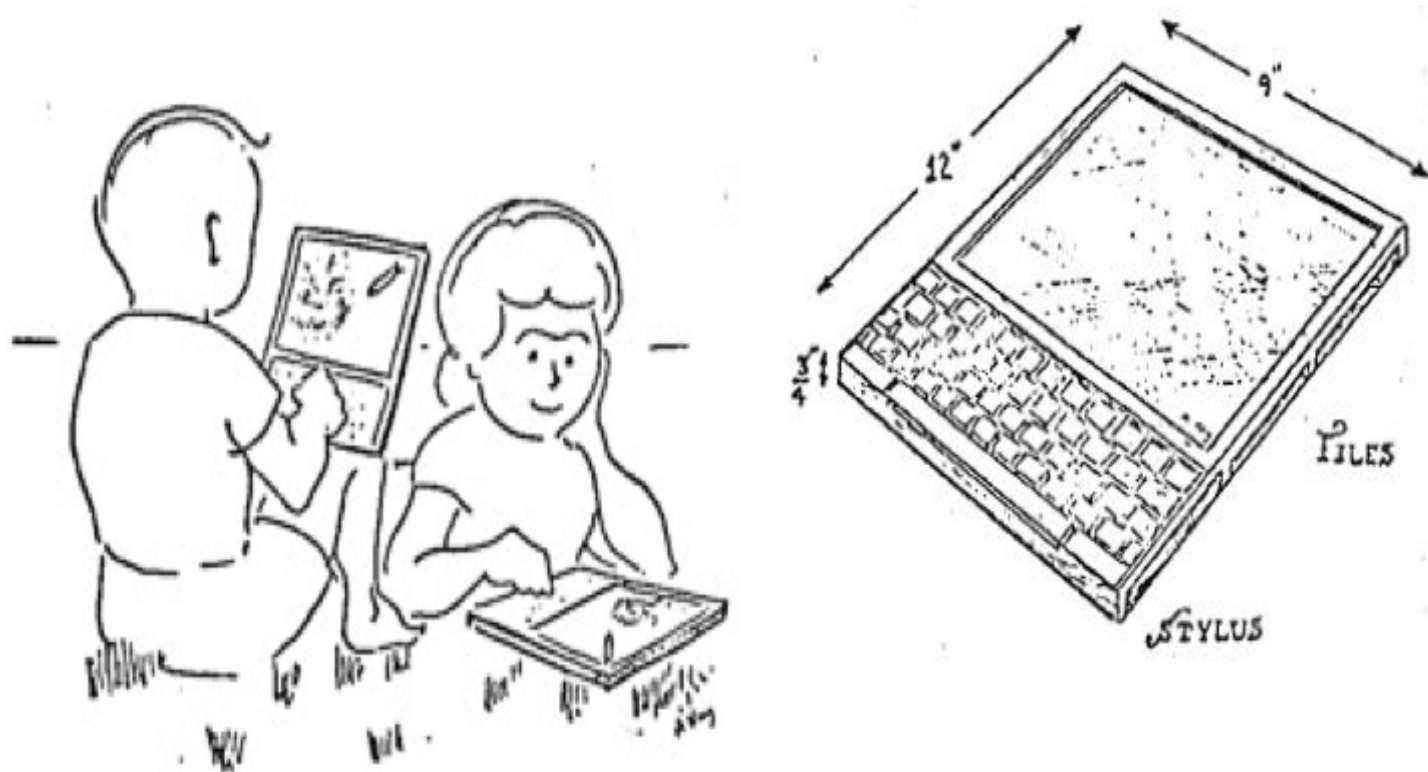


1er processeur dédié 3D pour PC (1995-97)



Etiquettes électroniques (e-ink)

## Etape 1 : l'ordinateur personnel (et pour tous ?)



<http://en.wikipedia.org/wiki/File:Dynabook.png>

**Le "dynabook" d'Alan Key (PARC, 1972)**

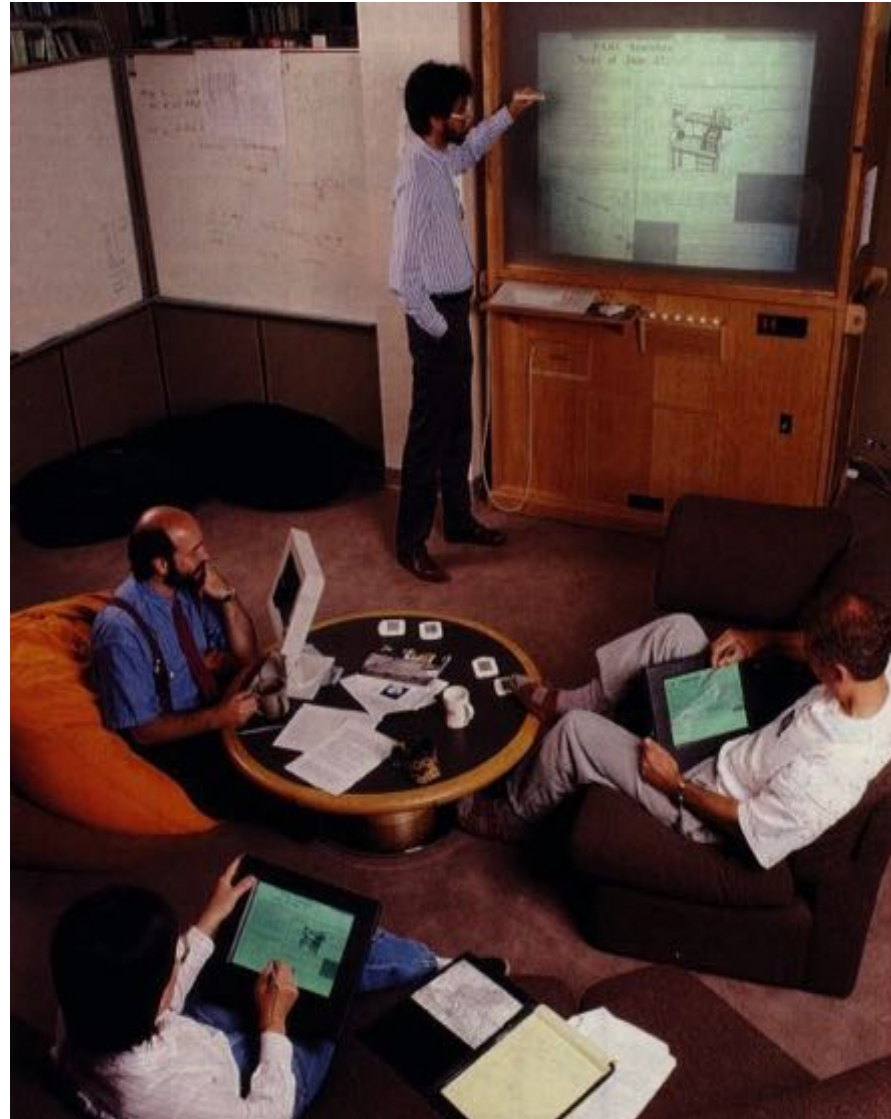


tablette apple en 2010 (et ipod touch en 2007)

**Etape 2 :  
l'information  
tout le temps**

Ubiquitous  
computing  
M. Weiser  
PARC, ca. 1990

(wikipedia)



moment et où que vous soyez sur votre  
ordinateur, iPhone™ et iPad™.



Entrez  
dans  
l'ère

de l'info continue

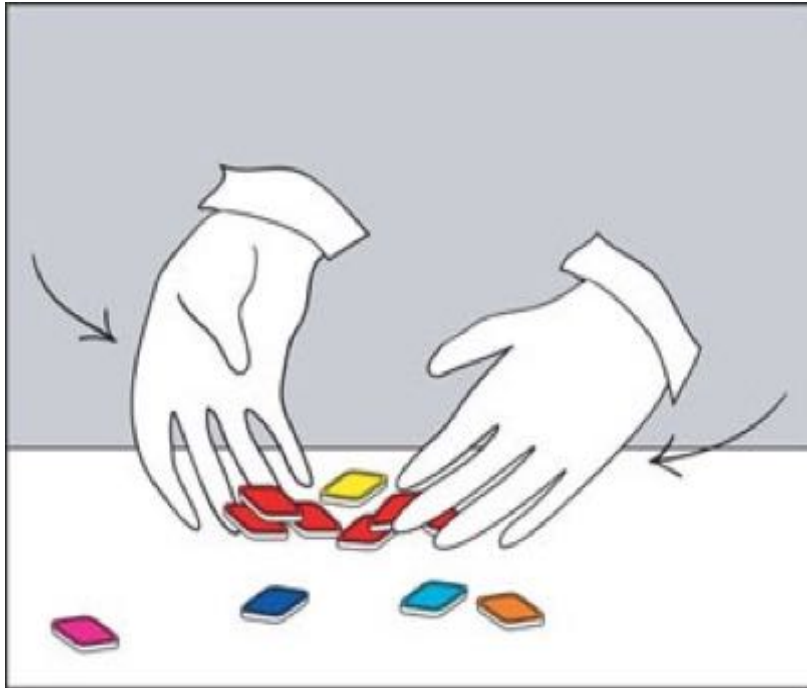
avec

Liberation

Abonnez-vous à l'offre intégrale pour seulement 9€ par mois pendant 3 mois  
et recevez en cadeau le Hors-Série «Mitterrand, une vie»\*.

pub circa 2012

## Etape 3 en cours : l'information dans tout



Siftables (Merill, MIT, 2009)



PhotoCubes (S.H. Hsu, CNAM, 2010)

## **(3) La captation**

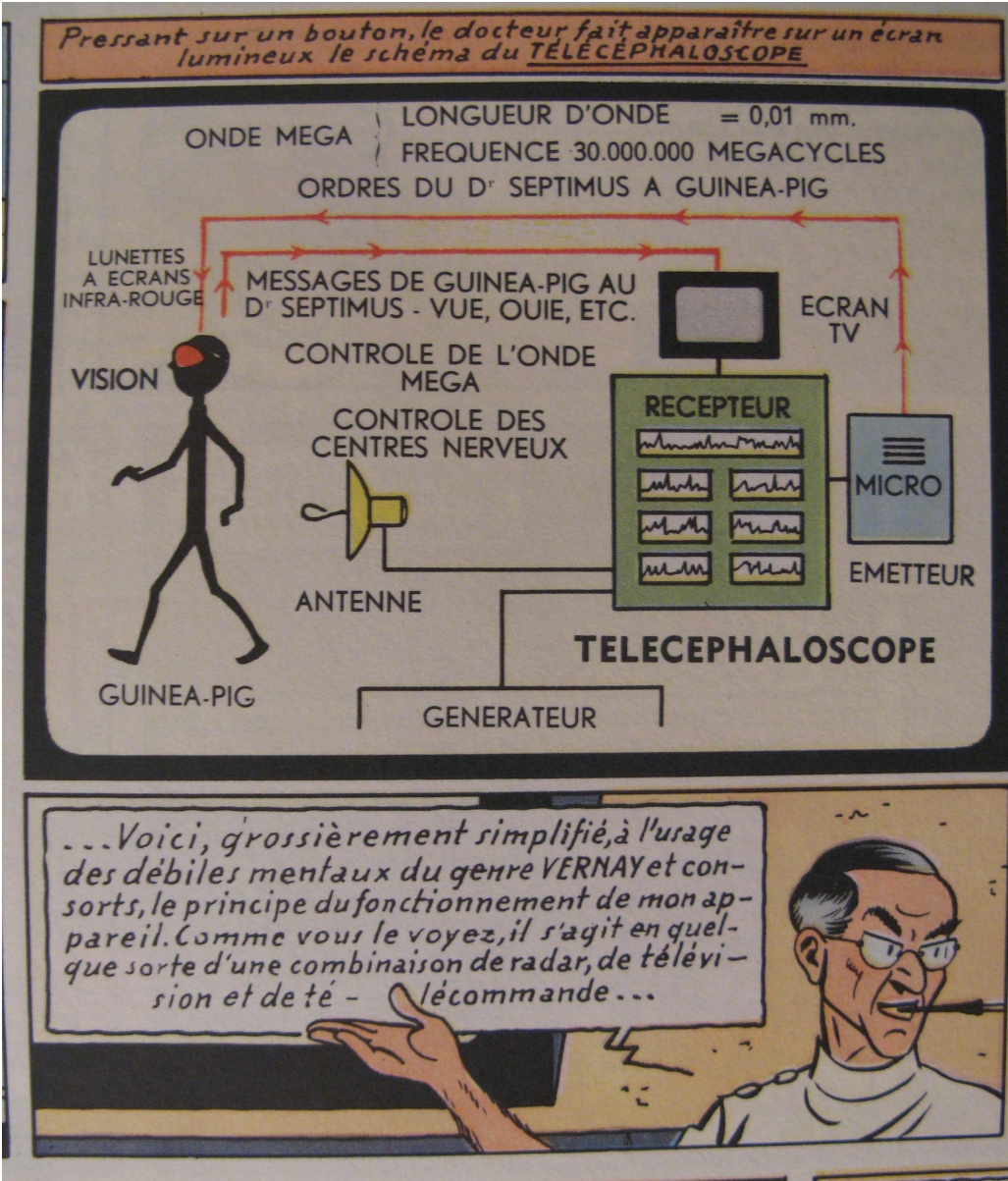


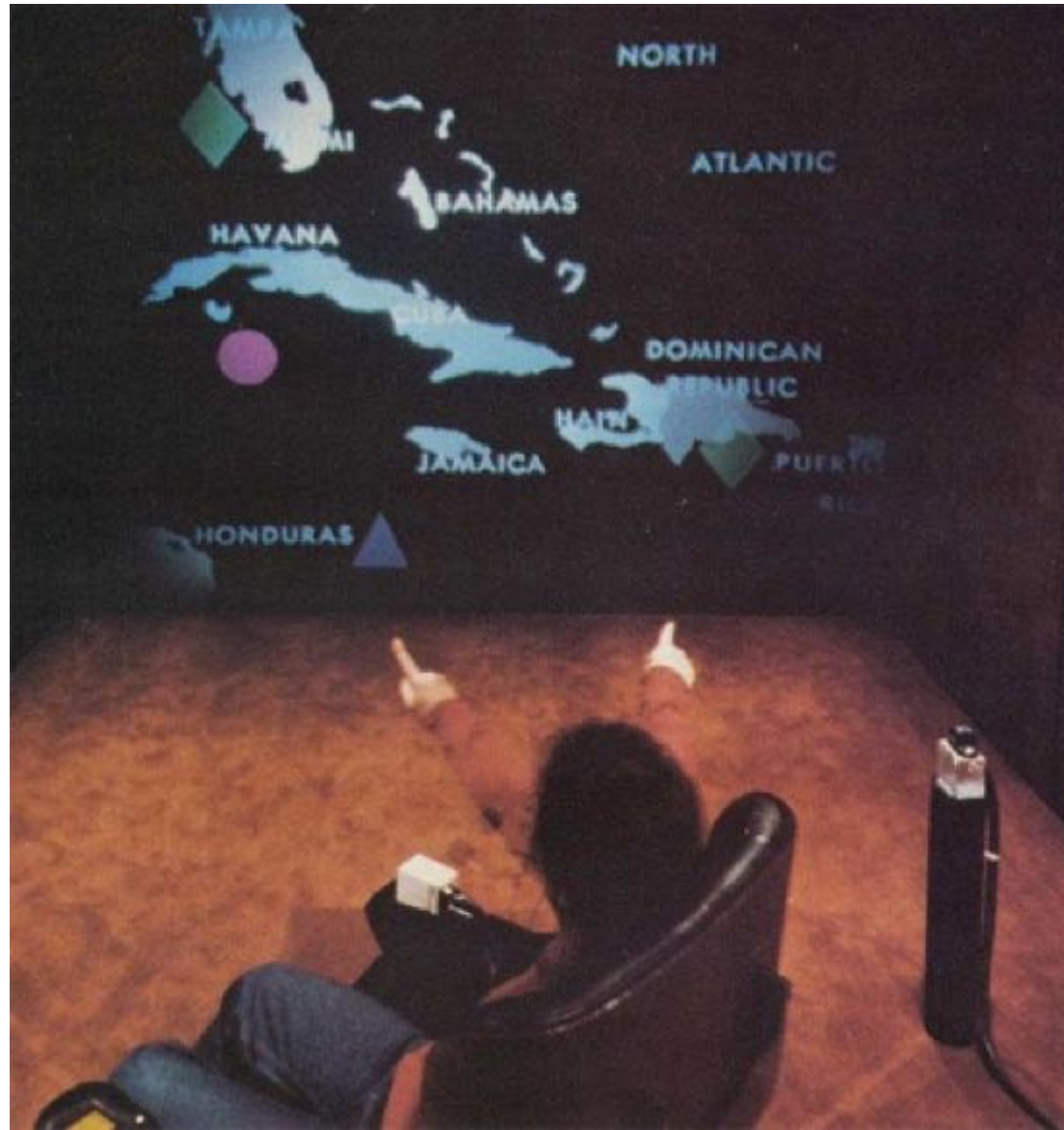
## **ce qu'on capte pour l'IHM :**

- position
- mouvement, déplacement
- geste
- voix : parole, chant
- attitude (attention)
- regard (direction)
- physiologie (temperature, rythme cardiaque, sudation ...)
- ondes cérébrales
- ...

**On ne traitera pas tout ici !**

# Capter pourquoi ? boucle de rétro-action (feedback)





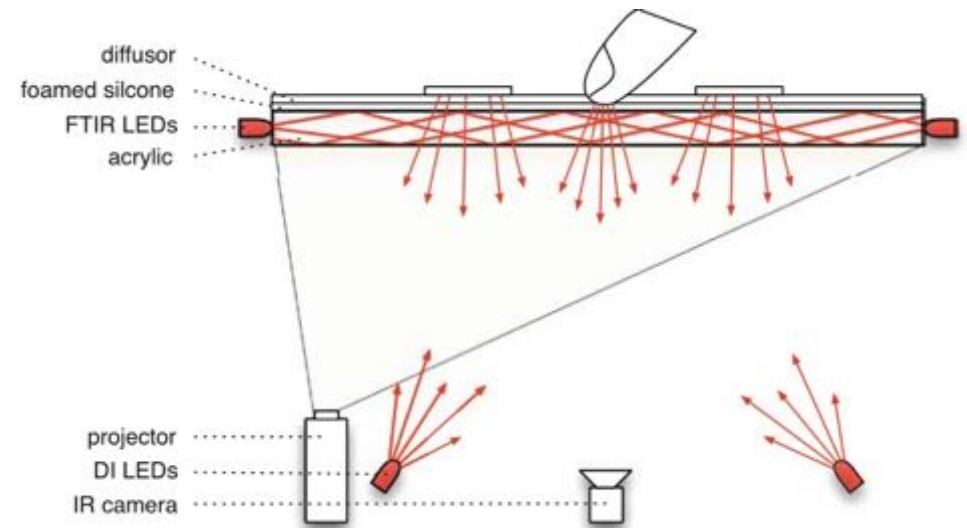
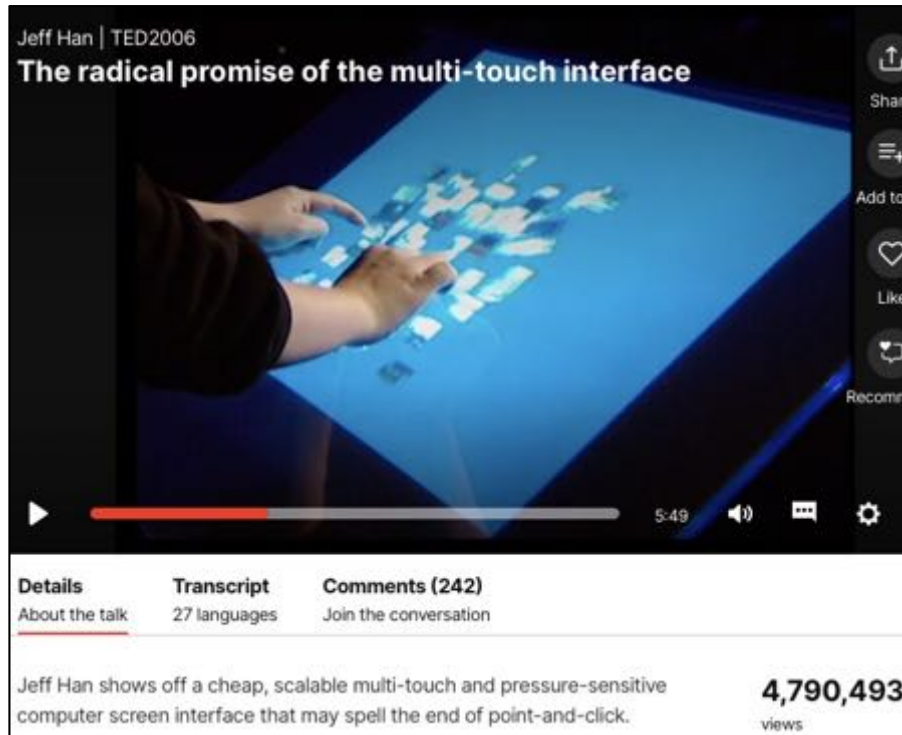
R. Bolt - "put that there" (MIT, 1980)

# Souris à 3 DDL, Rodrigo Almeida, CNAM/CEDRIC



procontrol & promidi pour Processing, OSC, etc

# Les tables d'affichages (tabletop displays)



Weiss, Malte & Hollan, James & Borchers, Jan & Müller-Tomfelde, Christian. (2010). Augmenting Interactive Tabletops with Translucent Tangible Controls.

voir la vidéo de la conférence  
TED 2006 de Jeff Han`  
+ son article UIST 2005

Microsoft Surface en 2007-8



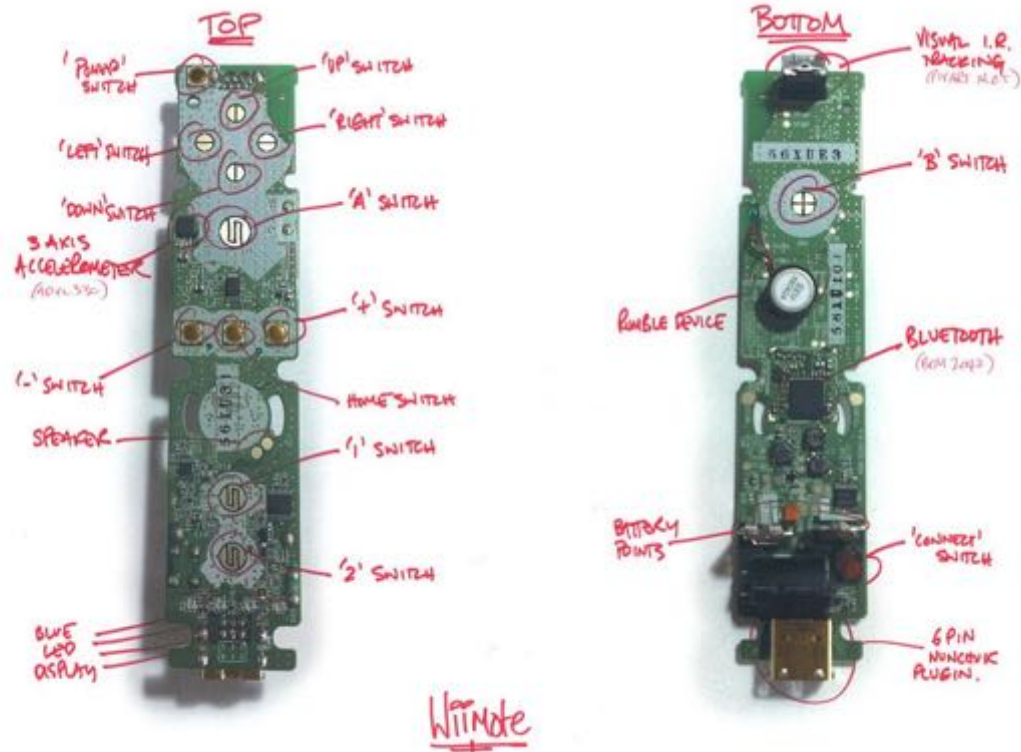
# C. Verplaetse IBM Systems Journal 35(3-4) 1996 !!

## Inertial proprioceptive devices: Self-motion-sensing toys and tools

by C. Verplaetse



# La Wiimote de Nintendo (2006)



Brett Rolfe, OneDigital

40 € wiimote + 20 € nunchuck

- accelerometre 3axes
- Camera IR + rec. Blobs
- HP, vibreur
- Plein de boutons + joysticks
- Bluetooth (et i2c avec le nunchuck)

Totalement « hacké »  
=> [www.wiili.com](http://www.wiili.com)

# Utilisation de l'accéléromètre



plus de demo depuis 2017 ☹️



# A la place : le nunchuk

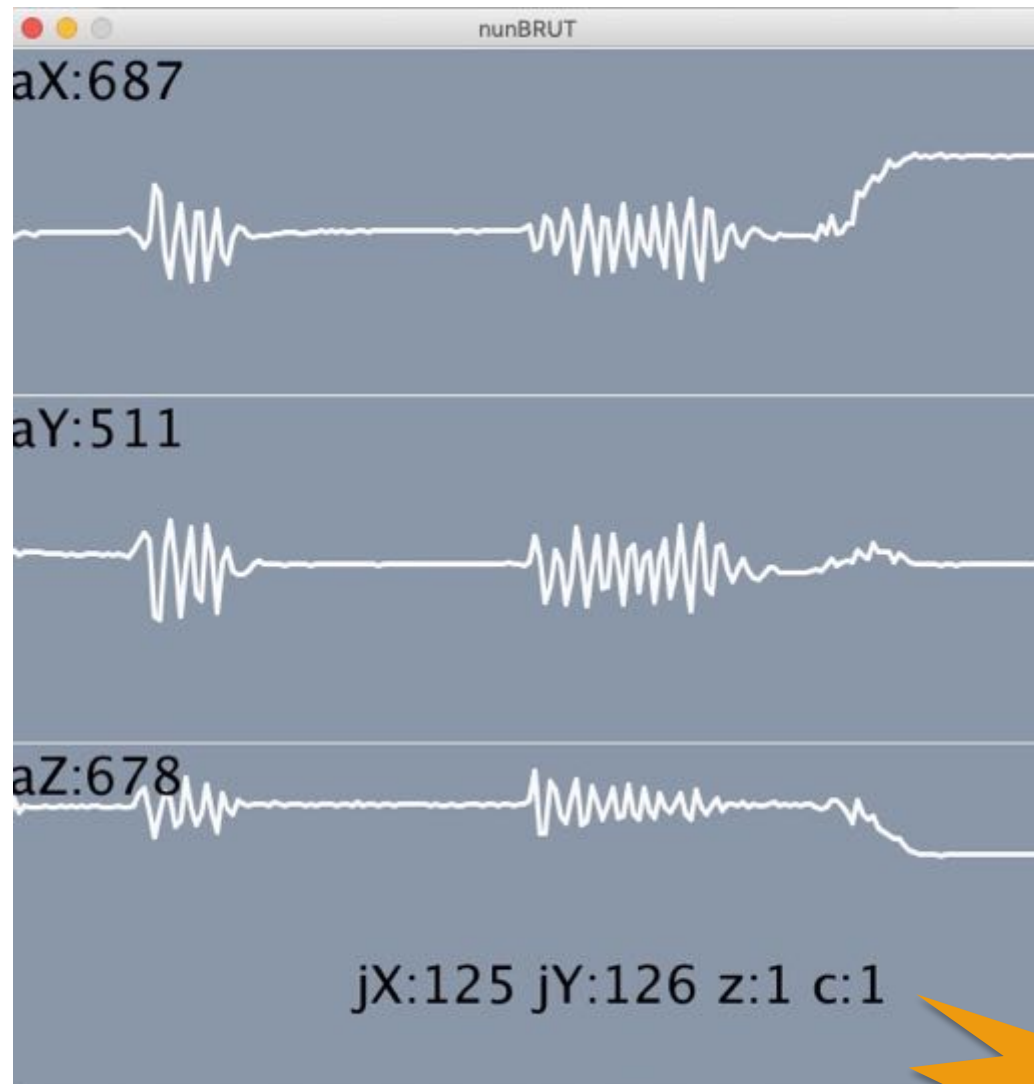


Acceleromètre STmicro  
(moins bon que wiimote ?)

Protocole i2c  
(deux fils E/S et deux fils alim)

Trame hackée aussi





démo

# Calibration de l'accéléromètre

On pose la wiimote de manière à avoir successivement les trois axes X Y Z à la verticale et on collecte les valeurs renvoyées.

+Z : x1, y1, z1

+Y : x2, y2, z2

+X : x3, y3, z3

d'où les coordonnées du point origine:

$$x0 = (x1 + x2)/2$$

$$y0 = (y1 + y3)/2$$

$$z0 = (z2 + z3) / 2$$

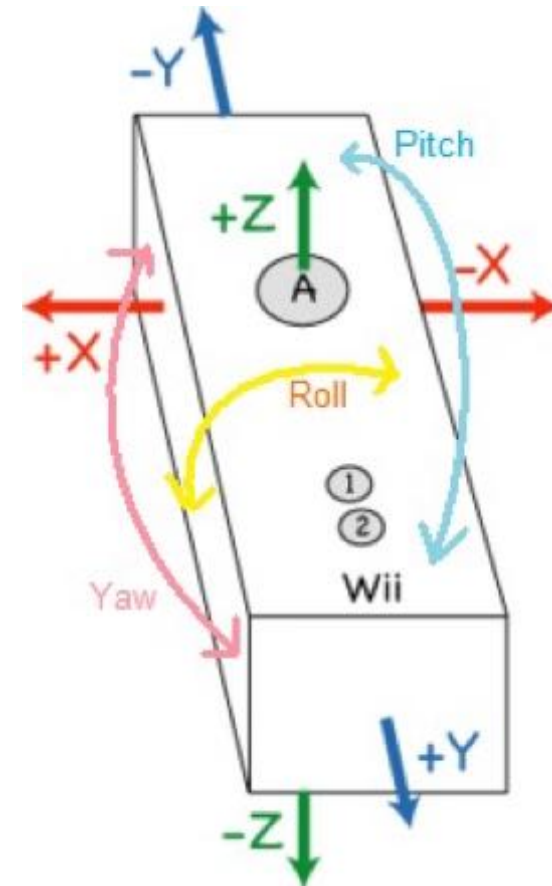
On obtient alors les coordonnées du vecteur force (exprimées en g) :

$$ax = (xraw - x0)/(x3 - x0)$$

$$ay = (yraw - y0)/(y2 - y0)$$

$$az = (zraw - z0)/(z1 - z0)$$

=> à faire pour chaque exemplaire (une fois)

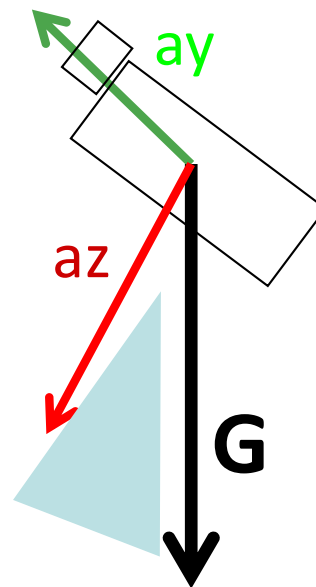


# application à la mesure d'angles d'orientation



ma (belle) lunette astronomique

vue de face :  
tangage (pitch)



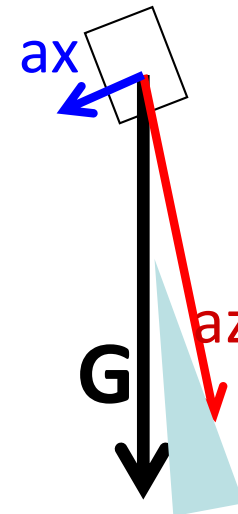
au repos :  $\text{tg}(\text{pitch}) = ay/az'$

$$\text{avec } az' = \sqrt{ax^2 + az^2}$$

$$\text{tg}(\text{roll}) = ax/az''$$

$$\text{avec } az'' = \sqrt{ay^2 + az^2}$$


vue de l'arrière :  
roulis (roll)



+ filtrage alpha ou Kalman : cf cours captation d'Octobre

nunKAL

ROLL : 88  
PITCH : 171



a/s)

```
// valeur apres calibration
ax = (ax - 600)/(821-600);
ay = (ay - 485)/(690-485);
az = (az - 680)/(585-680);
// calcul des angles
roll = atan2(sqrt(ax*ax+az*az),ay);
pitch = atan2(sqrt(ay*ay+az*az),ax);
// avec filtrage ou sans
alpha = (filtrage)?0.99:0;
rollf = alpha*rollf + (1-alpha)*roll;
pitchf = alpha*pitchf + (1-alpha)*pitch;
// affiche les infos
```

démo

il faut un filtrage fort  
pour le nunchuk  
≠ wiimote

moins précis aussi...

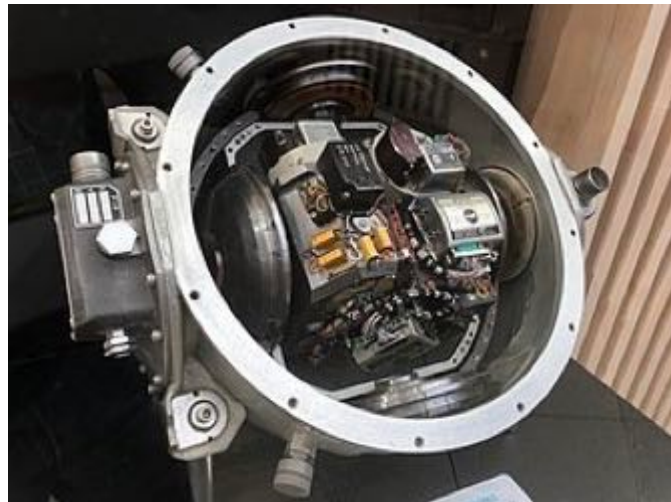
# Centrales inertielles (IMU : inertial measurement unit)



le missile V2

On ajoute l'angle manquant !

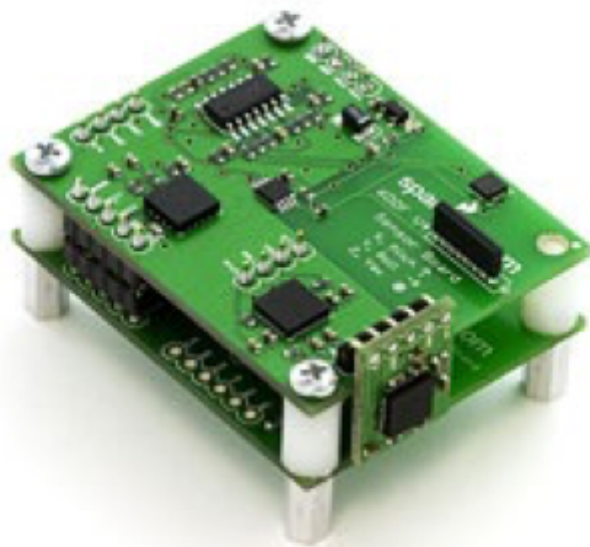
yaw = attitude = lacet



IMU appolo

(images wikipedia FR et EN)

# Enormes progrès en 10 ans (prix, stabilité, précision)



Sparkfun :

dizaine d'€  
zero soft



Xsense :

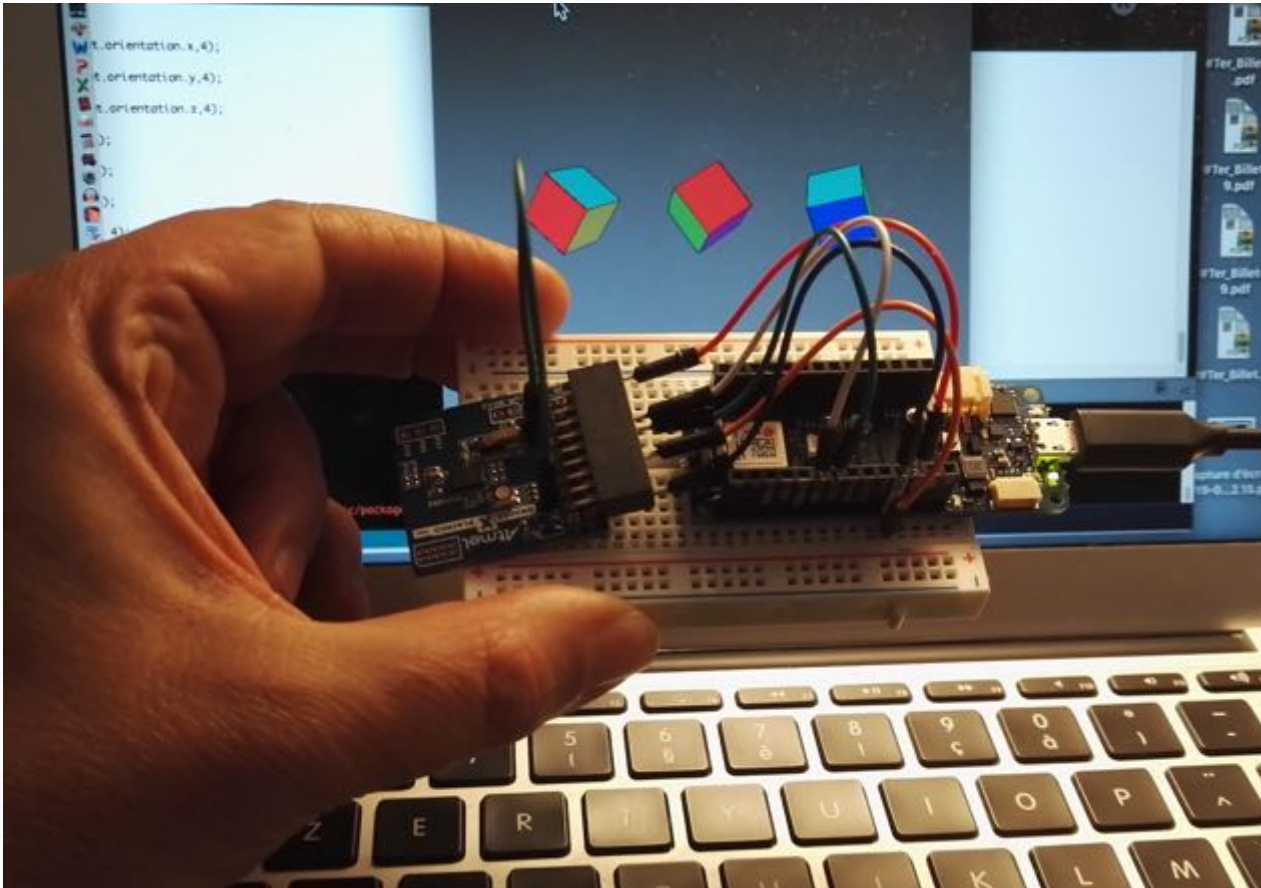
millier d'€  
soft mocap



Intersense : centaine d'€, bon soft



## Centrale inertielle DIY



basé sur l'IMU Bosch BNO 055 (filtrage intégré)  
carte ATMEL ATBNO055-XPRO ( $\pm 25\text{€}$ )  
en i2c sur Arduino MKR1010 (wifi)

démo

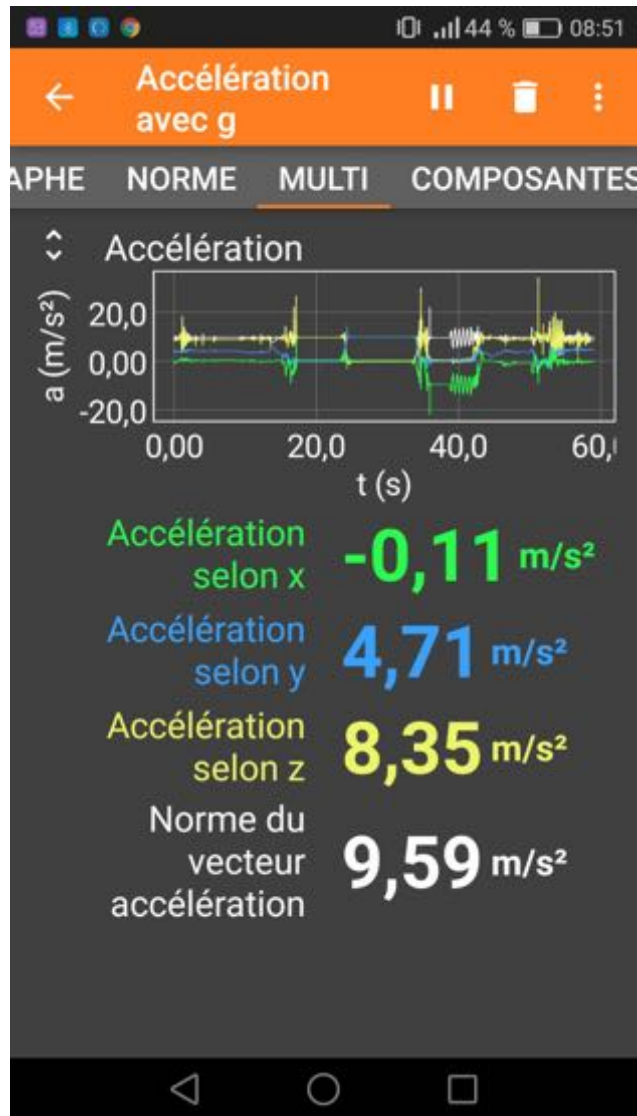


# Plus simple pour explorer : un smartphone

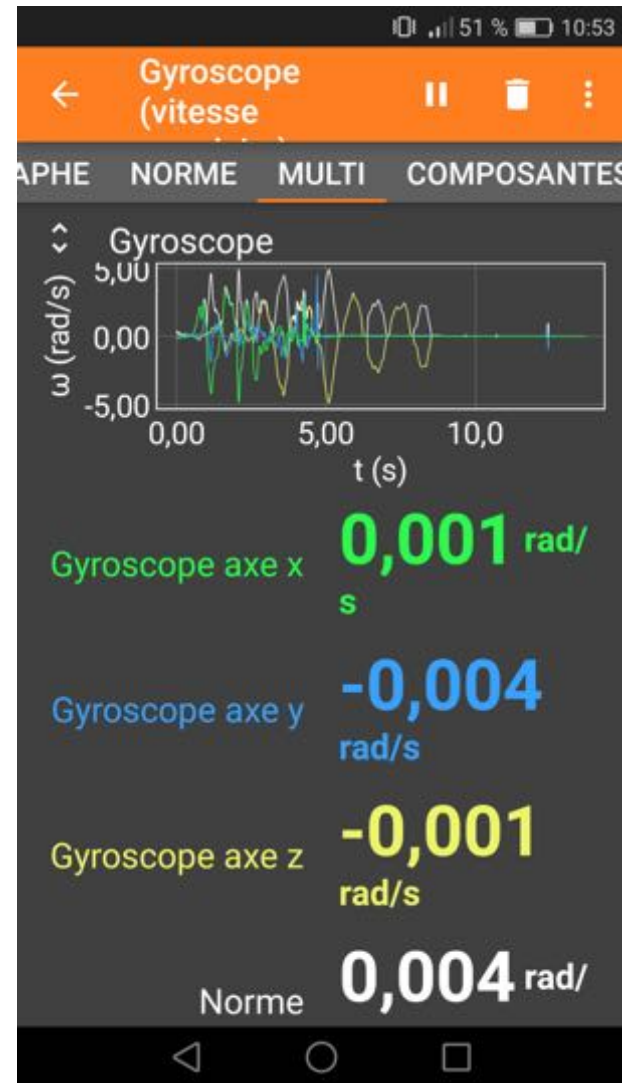


Appli Phyphox

## acceleromètres



## gyroscopes



A lire !

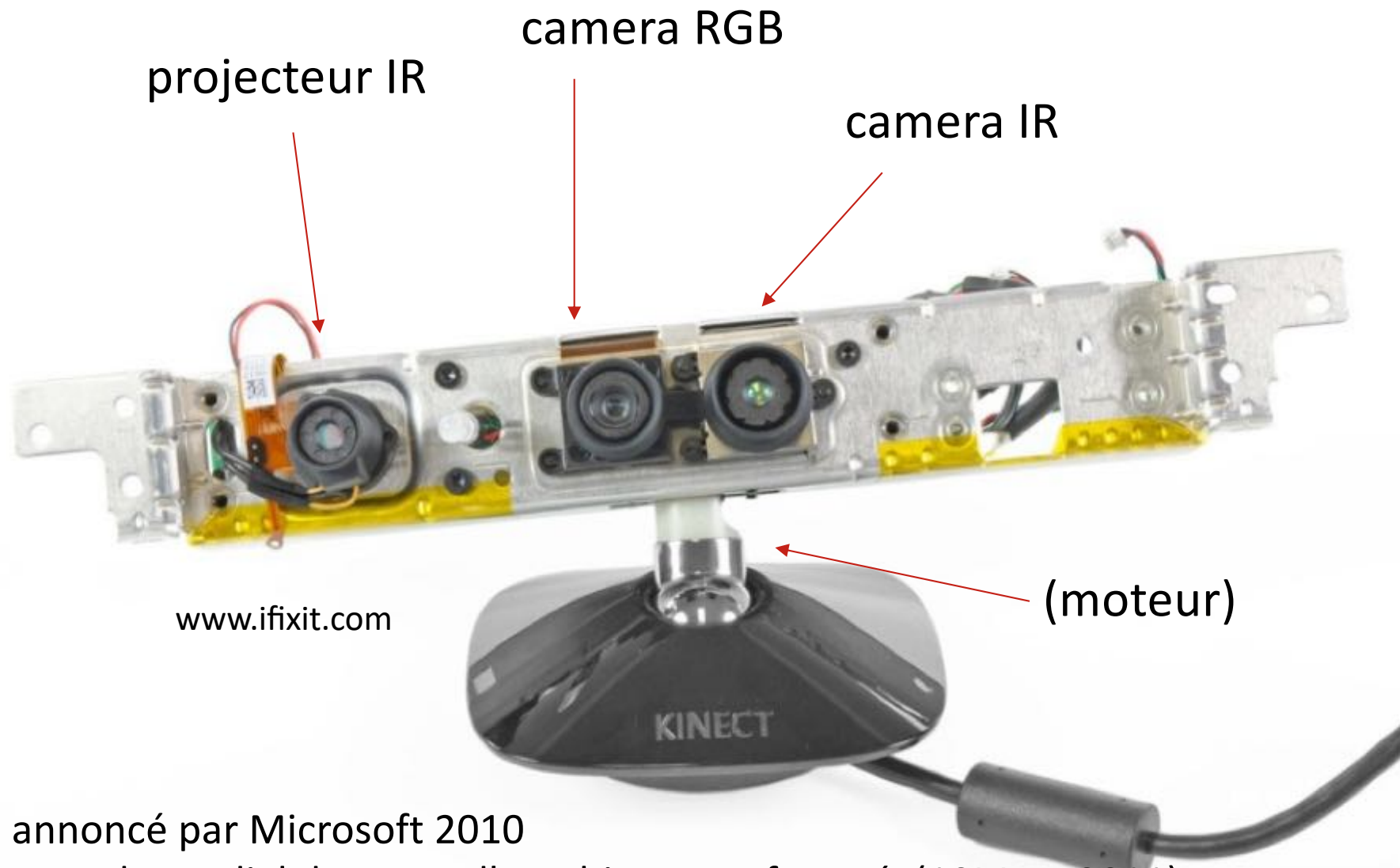


## Un exemple : "collective loops"



"Designing Collaborative Co-Located Interaction for an Artistic Installation"  
O. Mubarak, P. Cubaud, D. Bihanic, S. Bianchini, INTERACT'2017

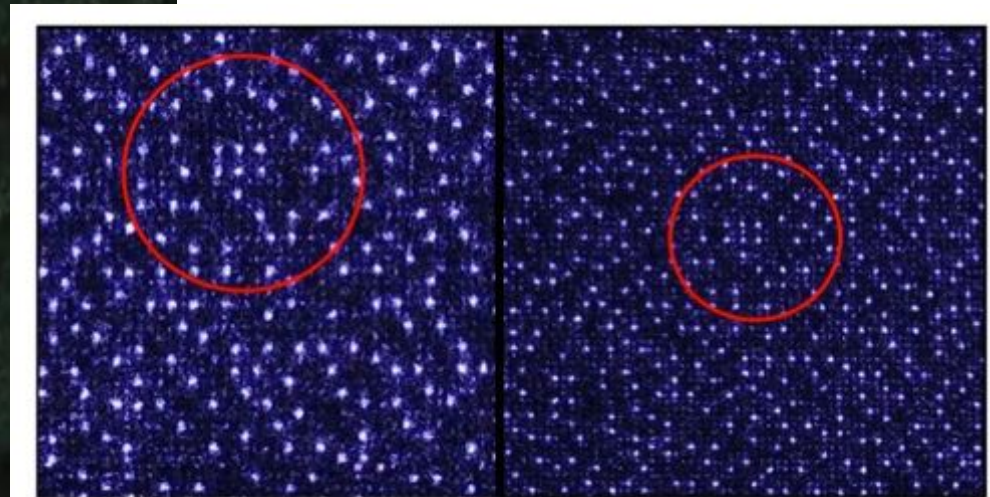
# Kinect



- annoncé par Microsoft 2010
- record mondial de vente d'un objet manufacturé (10M en 2011)
- soft+puce de reconnaissance de forme : société PrimeSense (Israël)

## Principe de la reconstruction 3D :

- le projecteur IR diffuse un semis de point sur les surfaces à analyser
- la caméra IR récupère l'image
- la position 3D est déduite en mixant 2 méthodes  
(1) la dimension des points (2) la triangulation



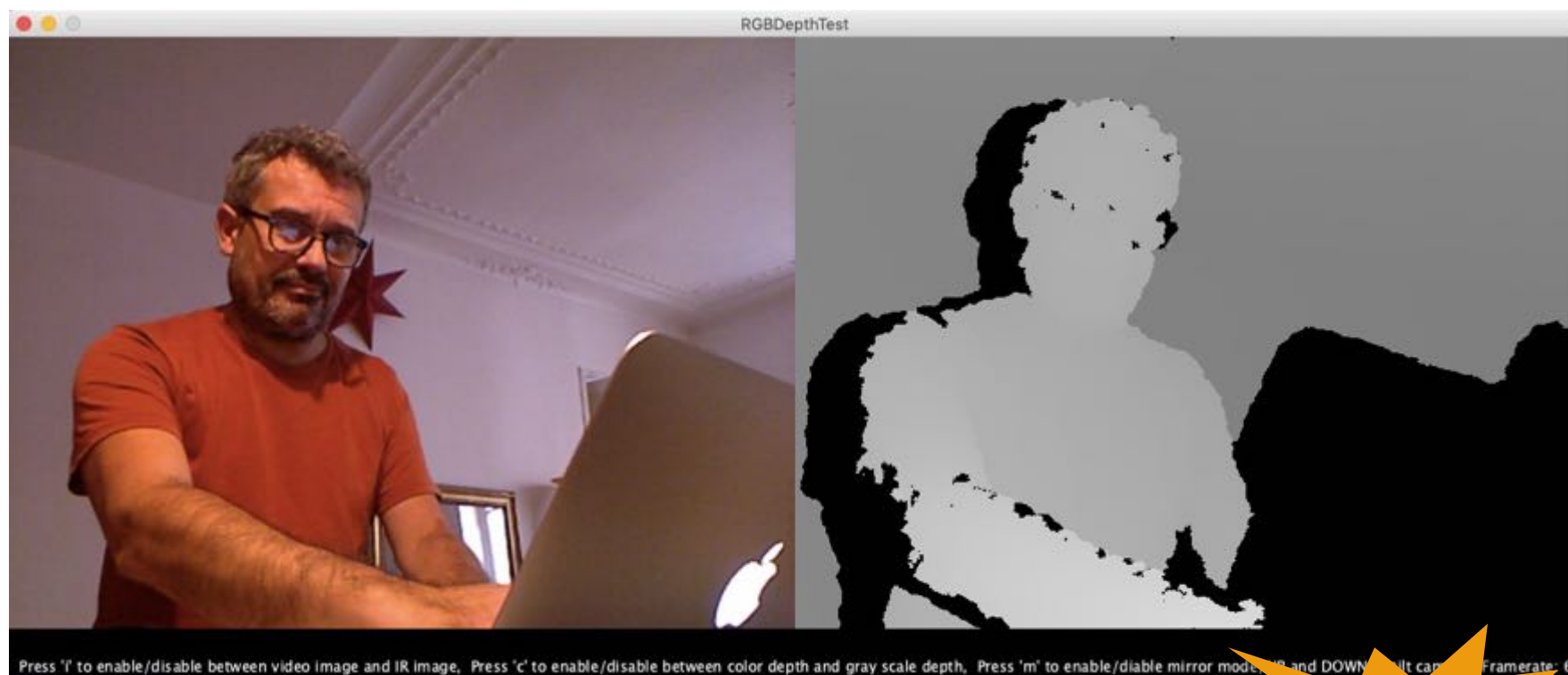
Pas tout à fait aléatoire !

il y a 3 types de motifs, adaptés aux distances  
=> bon topo en ligne: H. Wannous, Telecom Lille

## A lire sur la kinect :



## Processing 3 : librairie Open Kinect de Shiffman (alternative à SimpleNI - plus maintenue ?)



exemple de la librairie

démo

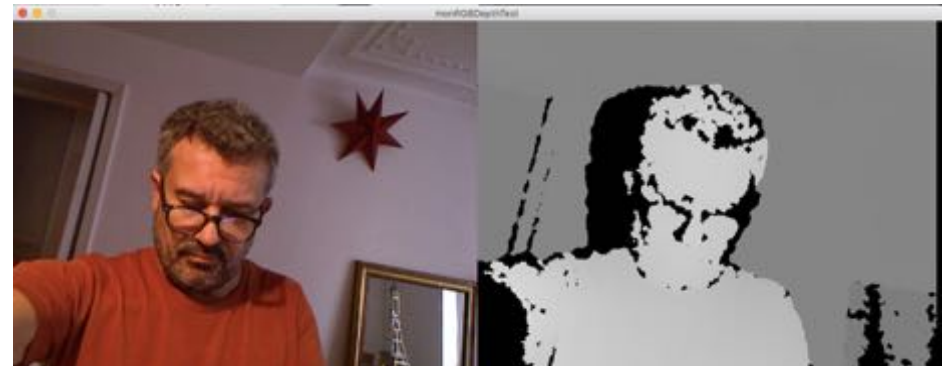


## La carte de profondeur (depthimage)

monRGBDepthTest ▾

```
import org.openkinect.freenect.*;
import org.openkinect.processing.*;
```

```
Kinect kinect;
void setup() {
  size(1280, 520);
  kinect = new Kinect(this);
  kinect.initDepth();
  kinect.initVideo();
}
void draw() {
  background(0);
  image(kinect.getDepthImage(), 640, 0);
  image(kinect.getVideoImage(), 0, 0);
}
```



**Exemple d'utilisation : fabrication d'un pointeur**  
avec le point le plus proche dans la depthmap comme pointeur



G. Borensten "Making things see" O'Reilly

## Code du livre

```
import SimpleOpenNI.*;
SimpleOpenNI kinect;
```

```
int closestValue;
int closestX;
int closestY;
```

```
void setup() {
  size(640, 480);
  kinect = new SimpleOpenNI(this);
  kinect.enableDepth();
}
```

il faudra  
filtrer le point

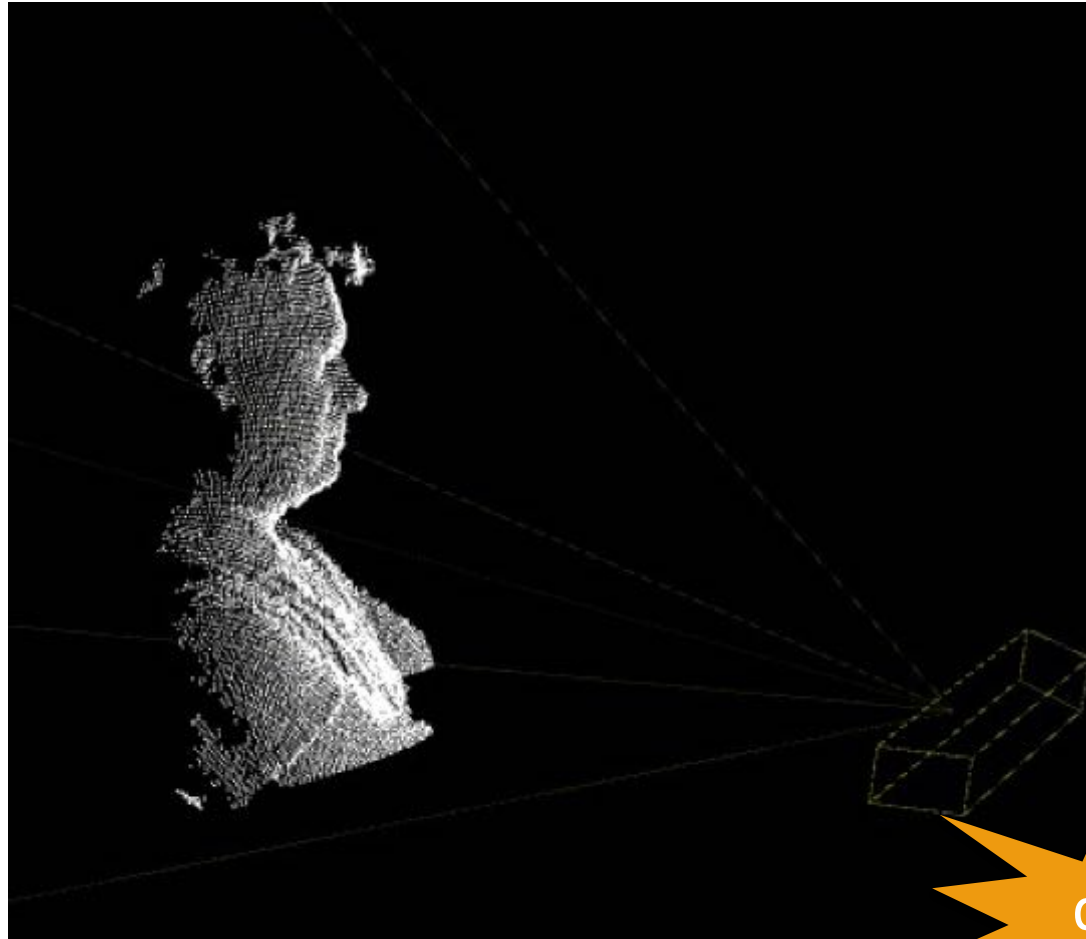
```
void draw() {
  closestValue = 8000;
  kinect.update();

  // get the depth array from the kinect
  int[] depthValues = kinect.depthMap();

  for(int y = 0; y < 480; y++){
    for(int x = 0; x < 640; x++){
      int i = x + y * 640;
      int currentDepthValue = depthValues[i];
      if(currentDepthValue > 0 && currentDepthValue < closestValue){
        closestValue = currentDepthValue;
        closestX = x;
        closestY = y;
      }
    }
  }

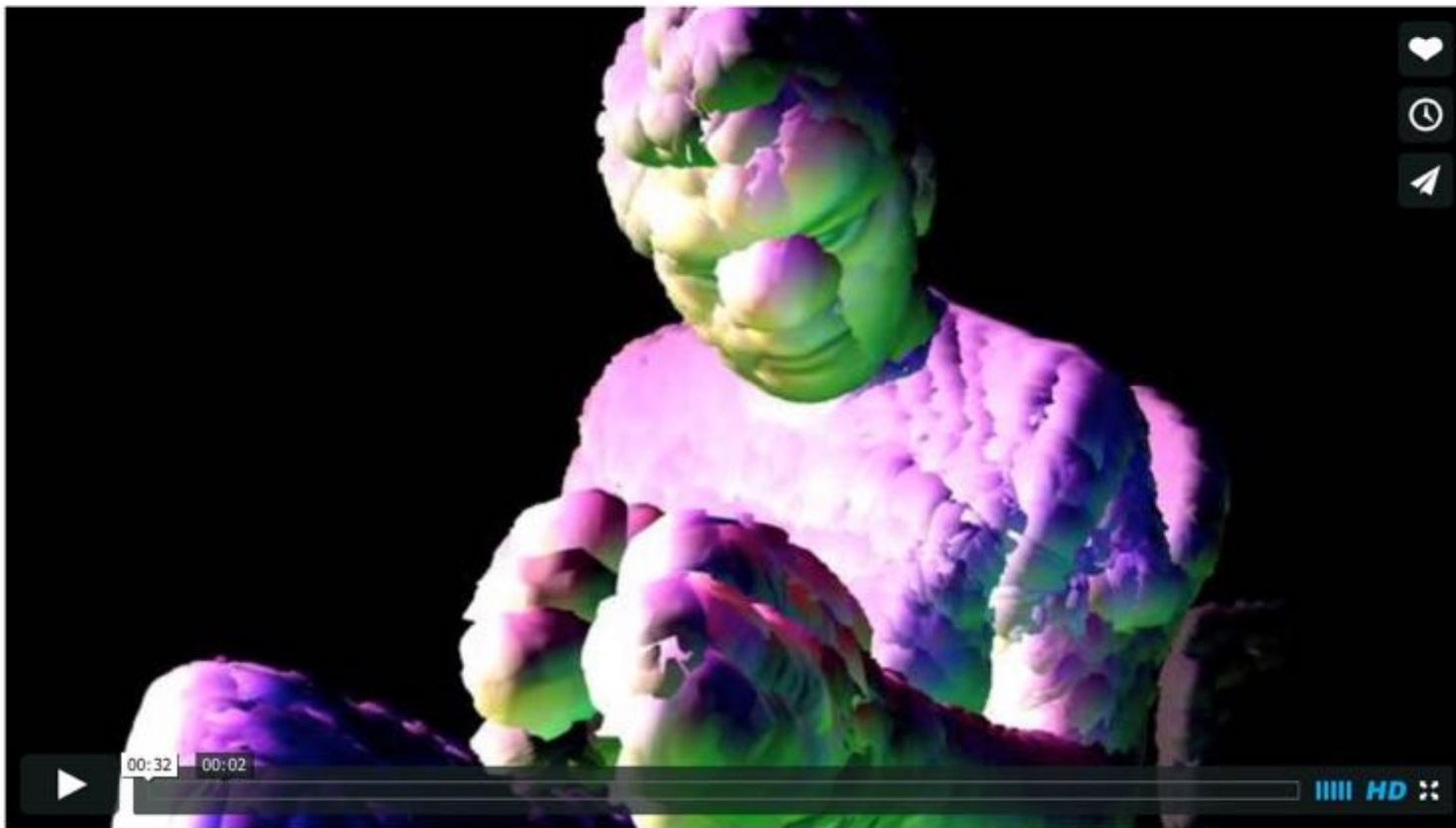
  //draw the depth image on the screen + le point le plus proche
  image(kinect.depthImage(),0,0);
  fill(255,0,0);
  ellipse(closestX, closestY, 25, 25);
}
```

## Reconstruction 3D basée sur la depthmap



démono

demo "DepthMap3d" de SimpleOpenNI  
reprise avec OpenKinect



## Body Dysmorphic Disorder

from **flight404** PLUS 3 years ago NOT YET RATED

Made with Cinder and the Kinect sensor. Runs in realtime.

[flight404.com/blog/?p=472](http://flight404.com/blog/?p=472)



# A voir ...

Microsoft Translator | Choose language

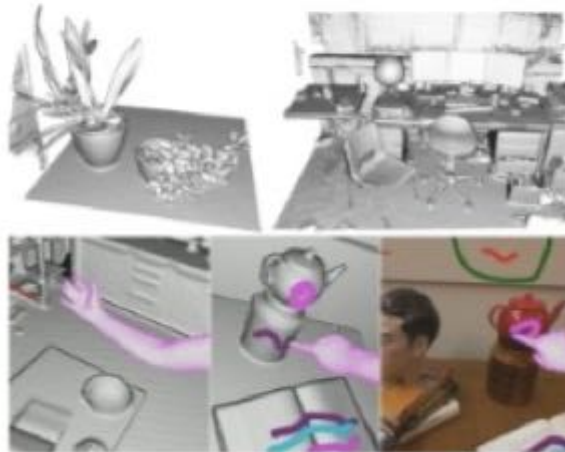
## Microsoft Research

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Search Microsoft Research

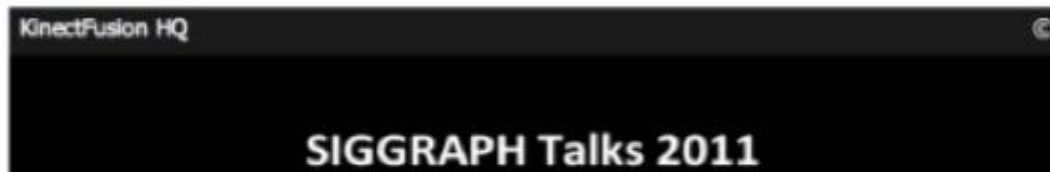
[All](#) [Downloads](#) [Events](#) [Groups](#) [News](#) [People](#) [Projects](#) [Publications](#) [Videos](#)

## KinectFusion Project Page



This project investigates techniques to track the 6DOF position of handheld depth sensing cameras, such as Kinect, as they move through space and perform high quality 3D surface reconstructions for interaction. Other collaborators (missing from the list below): Richard Newcombe (Imperial College London); David Kim (Newcastle University & Microsoft Research); Andy Davison (Imperial College London)

### Videos



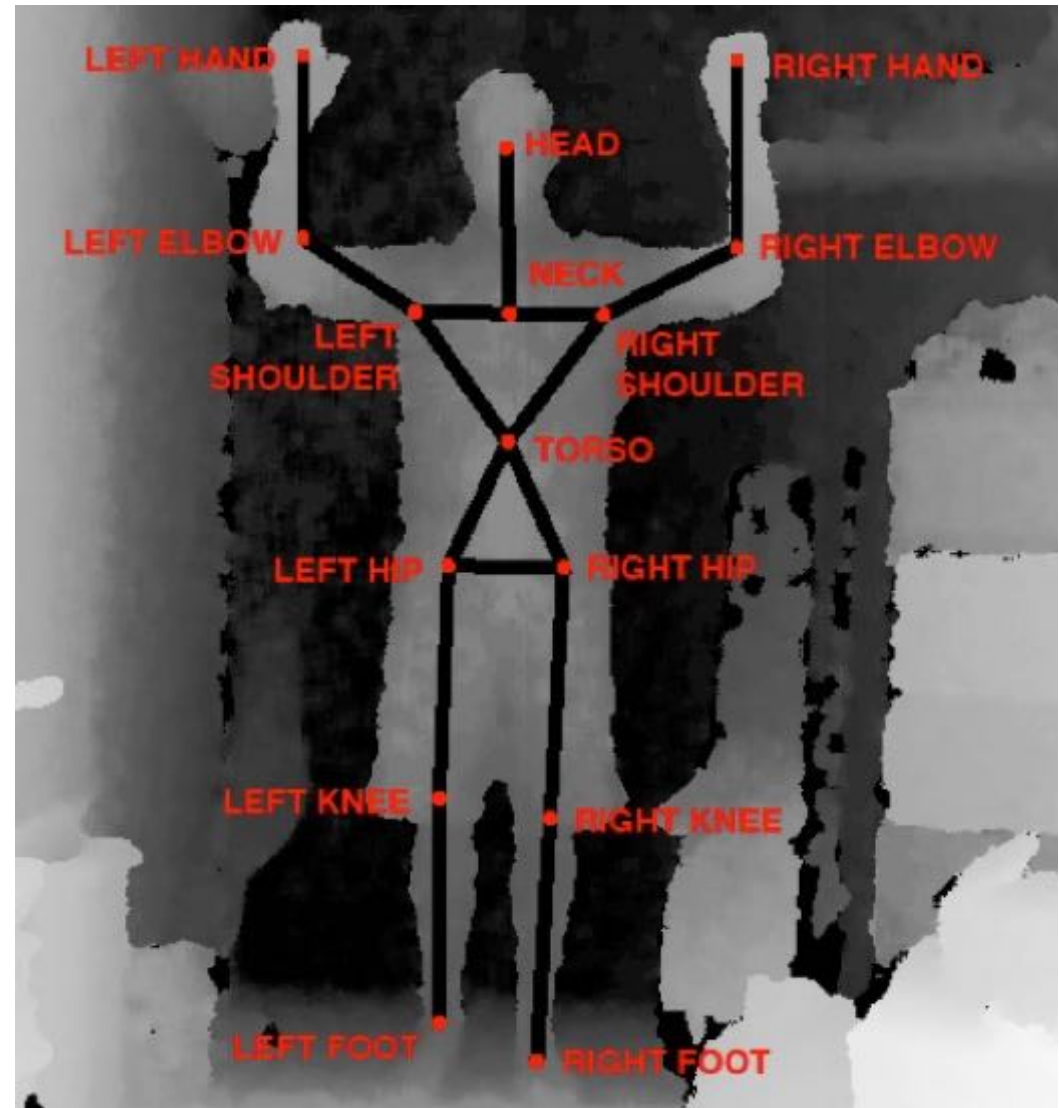
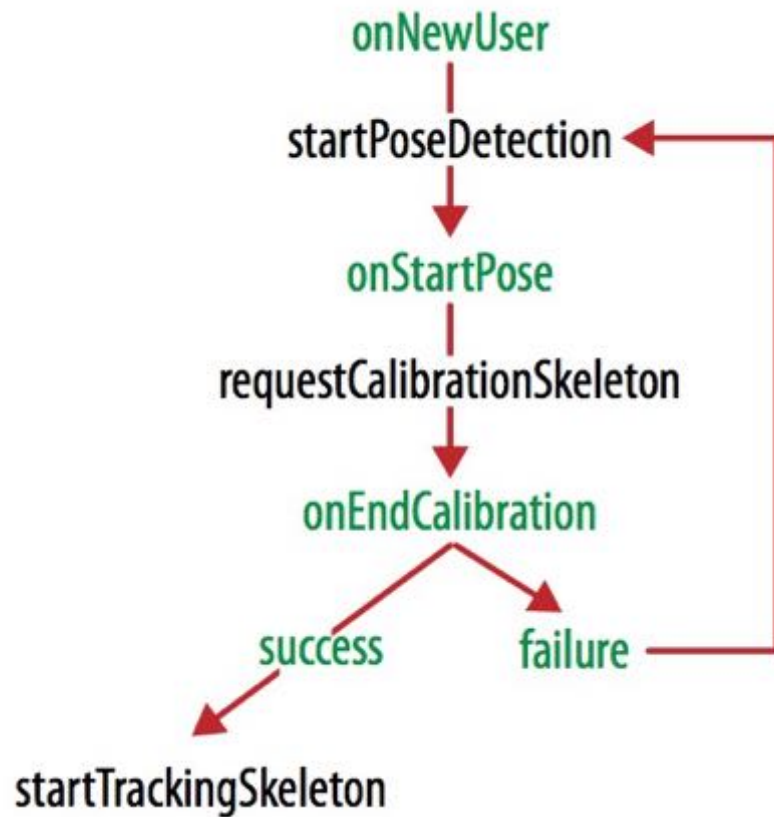
### Publications

- Shahram Izadi, David Kim, Otmar Hilliges, David Molyneaux, Richard Newcombe, Pushmeet Kohli, Jamie Shotton, Steve Hodges, Dustin Freeman, Andrew Davison, and Andrew Fitzgibbon, [KinectFusion: Real-time 3D Reconstruction and Interaction Using a Moving Depth Camera](#), ACM Symposium on User Interface Software and Technology, October 2011
- Richard A. Newcombe, Shahram Izadi, Otmar Hilliges, David Molyneaux, David Kim, Andrew J. Davison, Pushmeet Kohli, Jamie Shotton, Steve Hodges, and Andrew Fitzgibbon, [KinectFusion: Real-Time Dense Surface Mapping and Tracking](#), in *IEEE ISMAR*, IEEE, October 2011

+ des centaines d'autres projets de recherche

# Suivi du corps : demo "User" de simpleNI





G. Borensten "Making things see" O'Reilly



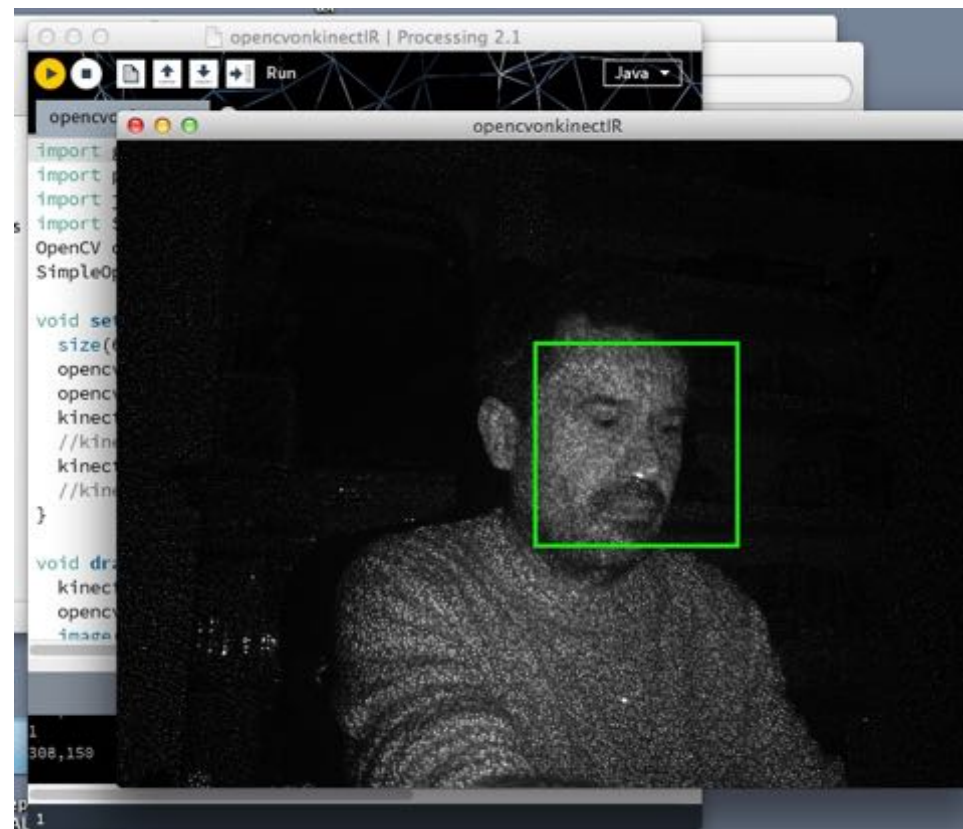
- séparation fond/humains
- identifications des humains



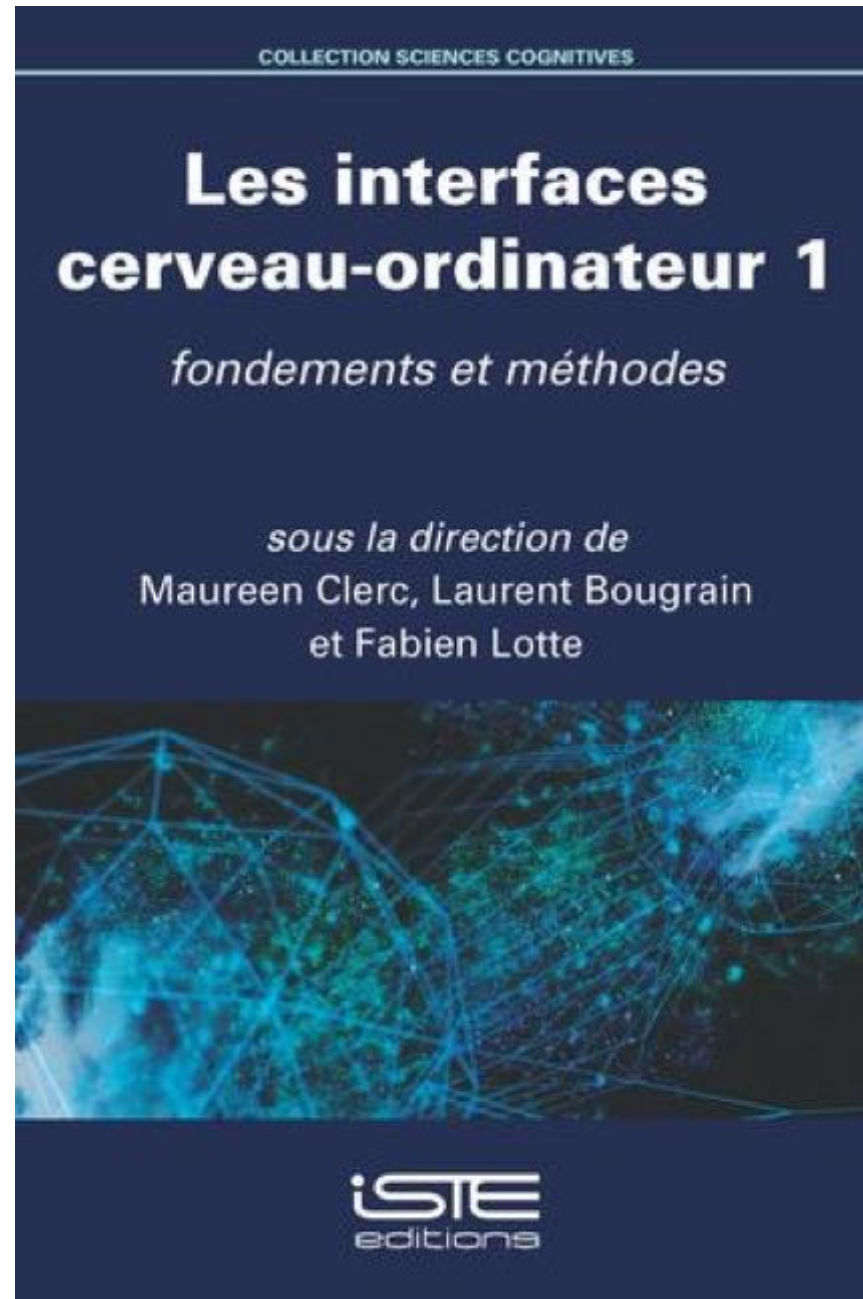
## Couplage Kinect - openCV



avec la depthmap



mais après ?





# Software for Brain Computer Interfaces and Real Time Neurosciences

[Downloads](#)[Features](#)[Documentation](#)[Forum](#)[FAQ](#)[Contact](#)

Dec 2018: OpenViBE v2.2.0 released

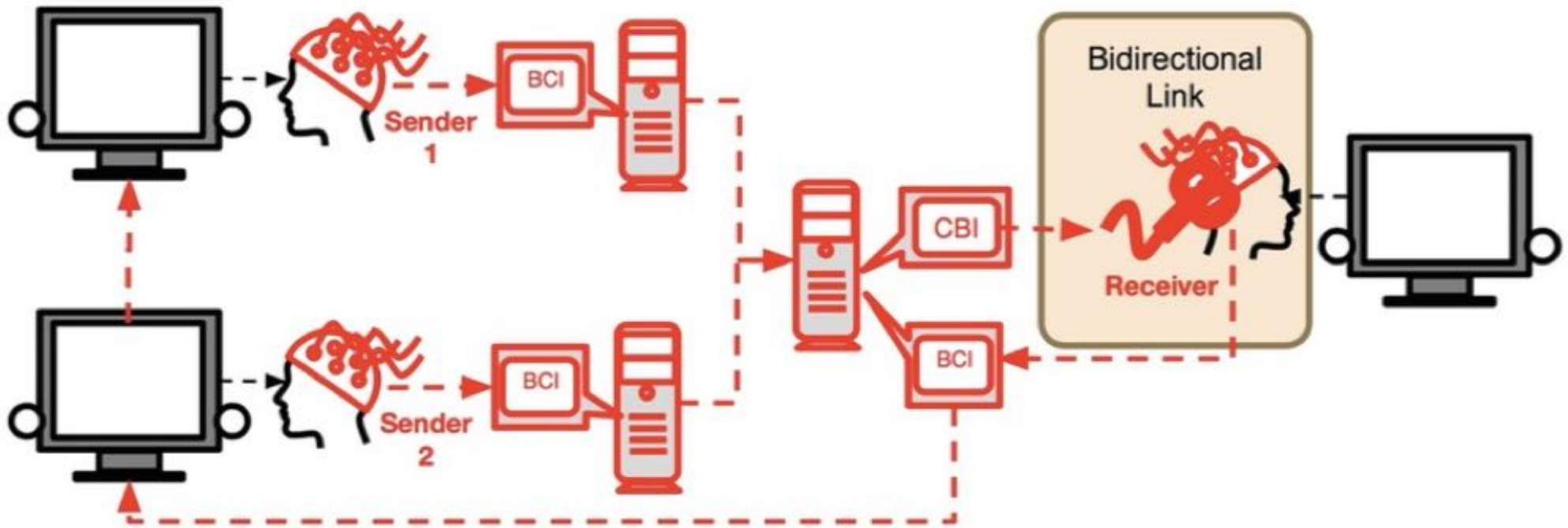
[Discover OpenViBE](#)[Download & Install](#)[Start using OpenViBE](#)

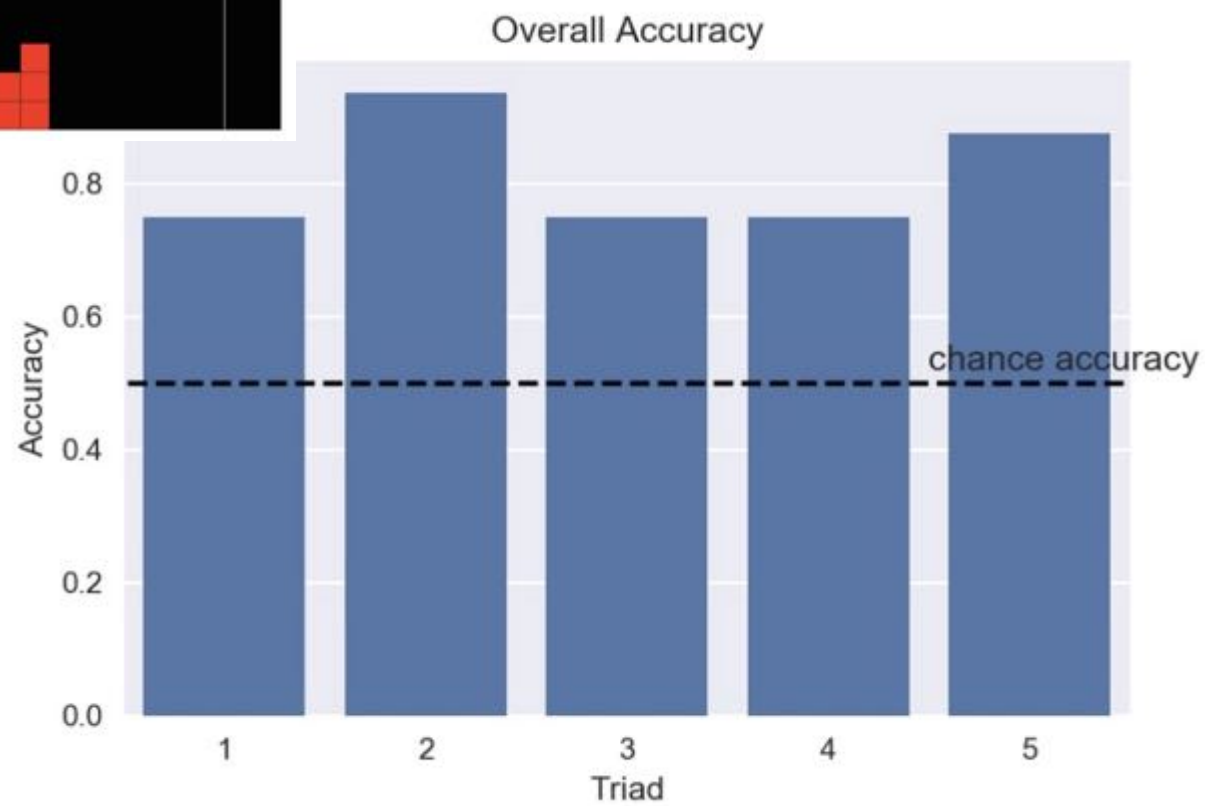
openVIBE de l'IRISA (Rennes)

en 2018 :

## BrainNet: A Multi-Person Brain-to-Brain Interface for Direct Collaboration Between Brains

Linxing Jiang<sup>1,\*</sup>, Andrea Stocco<sup>2,3,4,5</sup>, Darby M. Losey<sup>6,7,8</sup>, Justin A. Abernethy<sup>2,3</sup>, Chantel S. Prat<sup>2,3,4,5</sup>, and Rajesh P. N. Rao<sup>1,4,5,+</sup>





## **(4) Réalité étendue**

# Reality–virtuality continuum

From Wikipedia, the free encyclopedia

The **virtuality continuum** is a continuous scale ranging between the completely virtual, a *virtuality*, and the completely real, *reality*. The **reality–virtuality continuum** therefore encompasses all possible variations and compositions of real and *virtual* objects. It has been described as a concept in *new media* and *computer science*, but in fact it could be considered a matter of *anthropology*.<sup>[*clarification needed*][*citation needed*]</sup> The concept was first introduced by Paul Milgram.<sup>[1]</sup>

The area between the two extremes, where both the real and the virtual are mixed, is called *mixed reality*. This in turn is said to consist of both *augmented reality*, where the virtual augments the real, and *augmented virtuality*, where the real augments the virtual.



# réalité ?





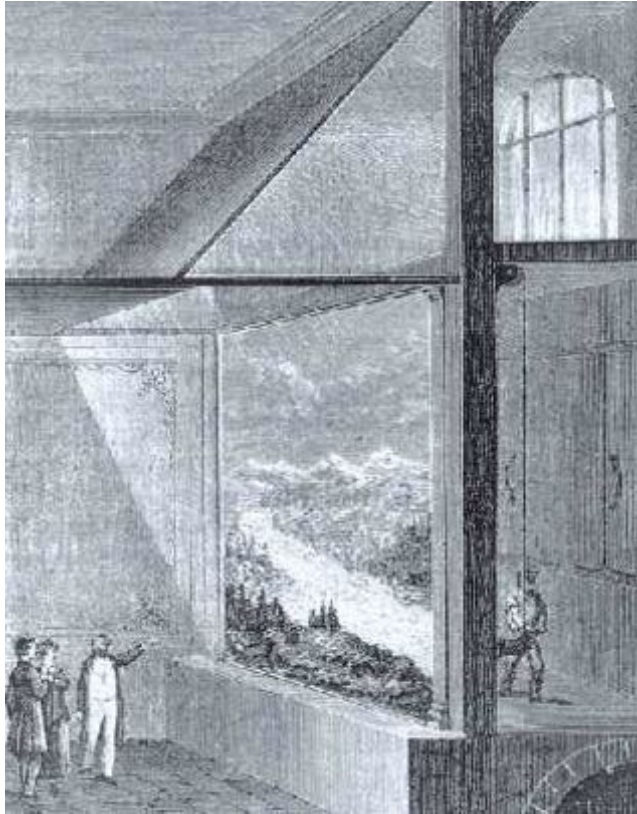


**Lascaux -15000  
réalité virtuelle ?**



**interrupteur dans mon salon  
réalité augmentée ?**

## Le diorama de Daguerre (1822)



<http://www.digischool.nl/ckv2/romantiek/romantiek/panorama/>

## Rue Léon Jouhaux (Xème)



Perception  
du relief :

Nombreux  
Indices

- Monoculaires
- Binoculaires



## Ex. de système binoculaire : le "mexicain"



<http://www.berezin.com/3d/holmes.htm>

(en kit 45€)

En monoculaire ?

Les expériences de J.C. Lee (HCI, Carnegie Mellon Univ., 2008)

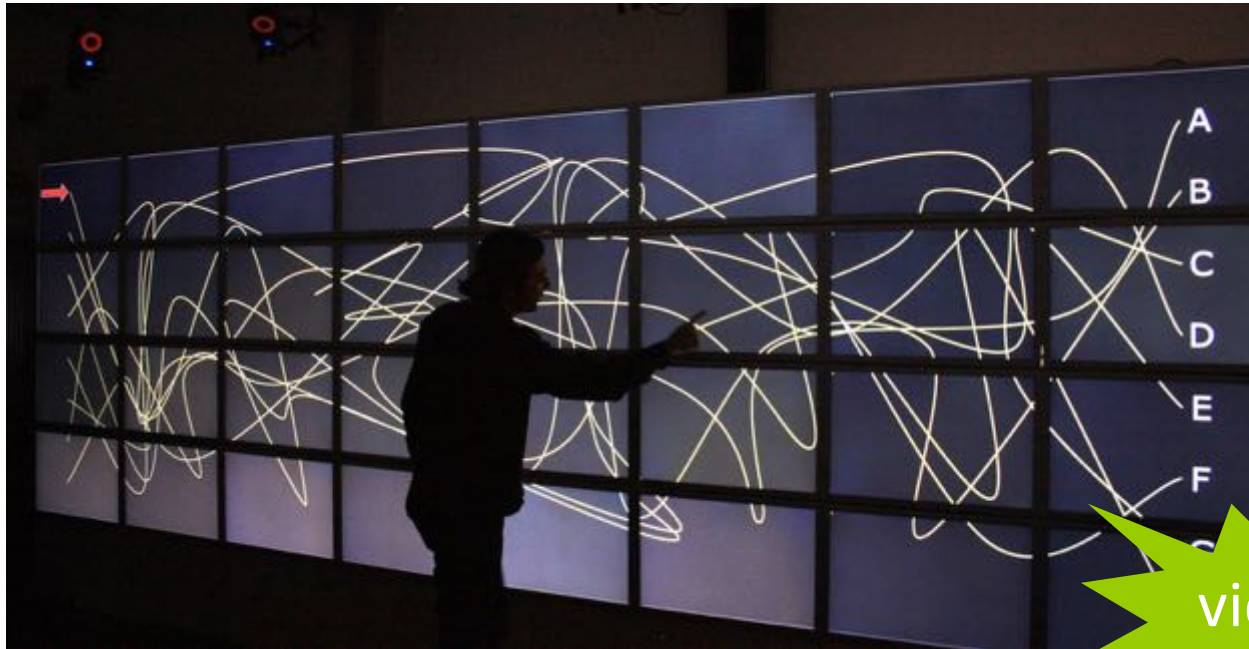


The image shows a screenshot of a YouTube video player. At the top left is the YouTube logo with the tagline "Broadcast Yourself™". Navigation buttons for "Home", "Videos", and "Channel" are visible. A search bar contains the word "Videos". The video title is "Head Tracking for Desktop VR Displays using the WiiRemote". The video frame shows a man with glasses and a plaid shirt sitting at a desk. Behind him is a computer monitor displaying a 3D grid with several glowing pink and purple spheres. Below the video frame is a progress bar showing "0:06 / 4:46". At the bottom, the video has a "Rate" of five stars and "19,980 ratings", and "Views: 5,349,510".



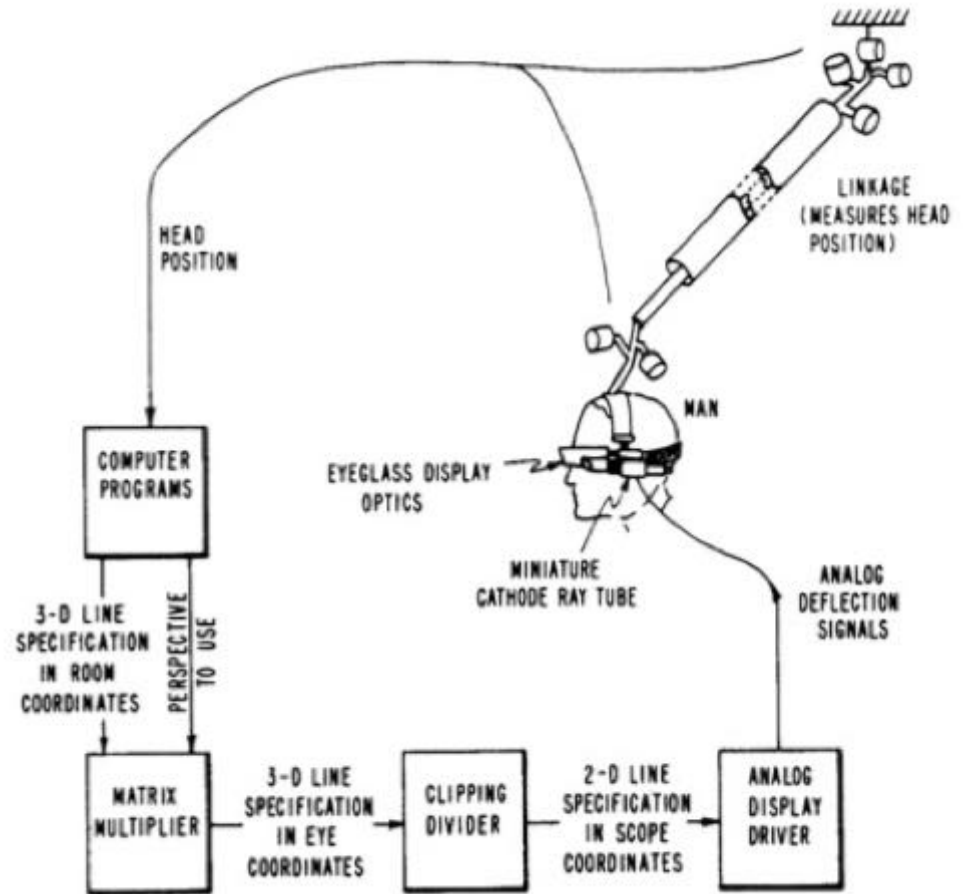
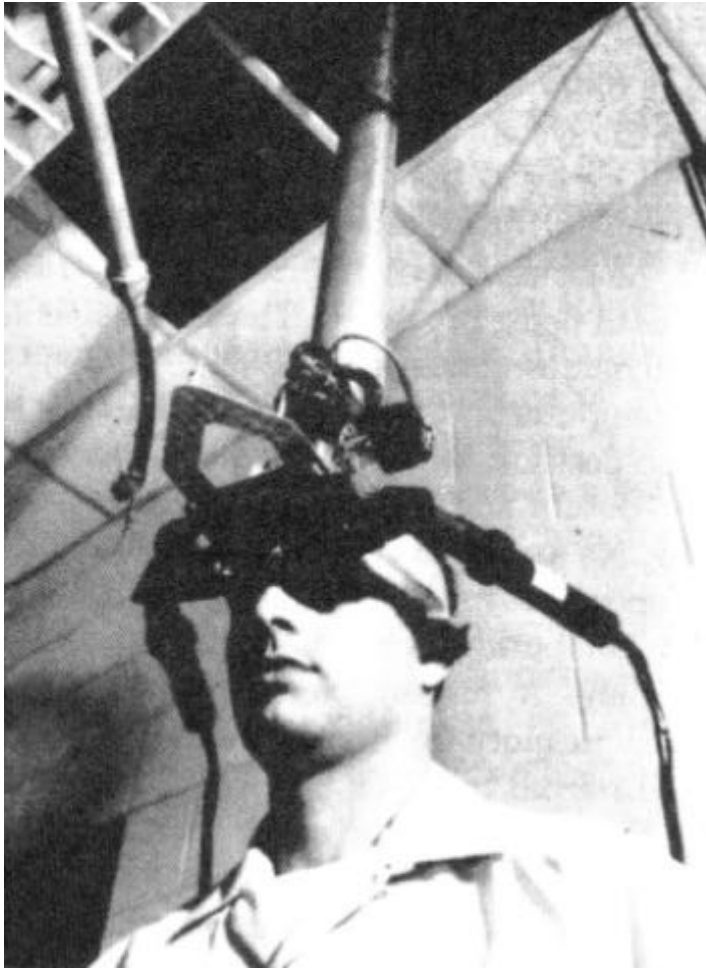
<= 11M en 2015

## Reprise sur mur d'écrans (INRIA+CNAM, 2012)



- 8 x 4 = 32 écrans LCD 30" => 5.5m x 1.8m and 131 Mpix
- cluster de 16 macpro avec 16 x 2 nvidia 8800GT
- capture mouvements video IR VICON (e<1mm, 200 Hz)





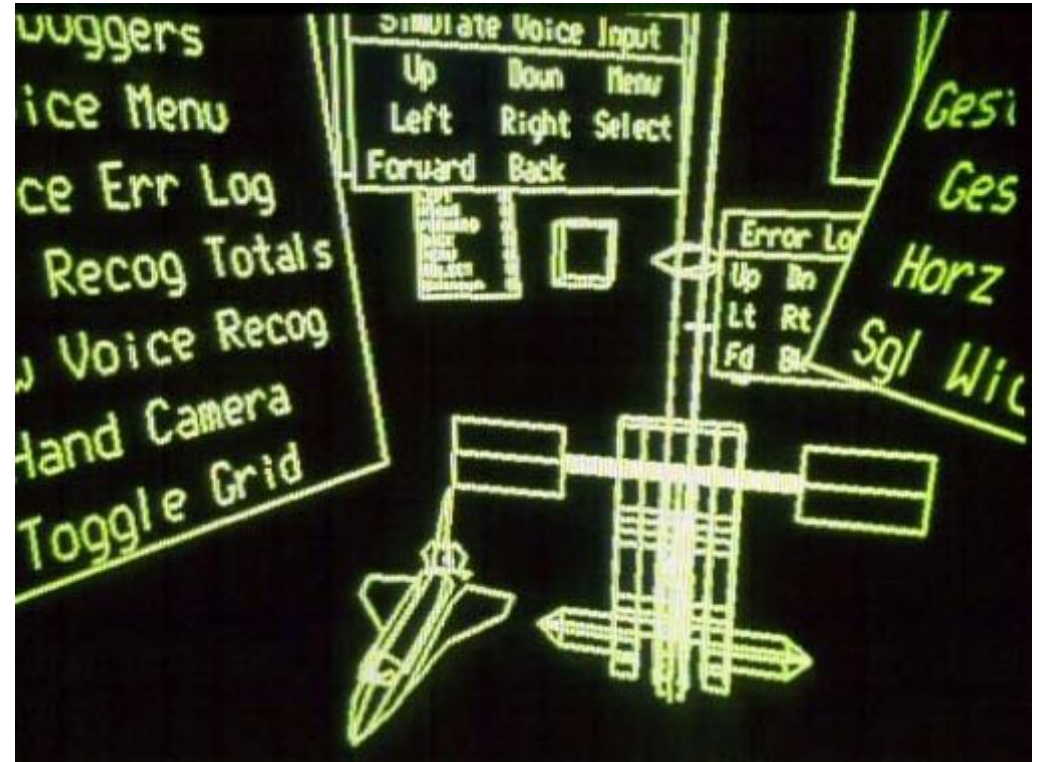
## I. Sutherland (1968)

## Ivan Sutherland - The ultimate display, 1965

The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.

<http://www.eng.utah.edu/~cs6360/Readings/UltimateDisplay.pdf>

La réalité virtuelle : Scott Fisher et al., Jaron Lanier (1985-7)



<http://itofisher.com/sfisher/>

<http://itofisher.com/sfisher/portfolio/files/viewlab.html>

# SCIENTIFIC AMERICAN

OCTOBER 1987  
\$2.50

*The next revolution in computers, the subject of this issue, will see power increase tenfold in 10 years while networks and advanced interfaces transform computing into a universal intellectual utility.*



*Wired Glove gives a computer user the sensation of handling objects on the screen: the image of the hand mimics the user's movements.*

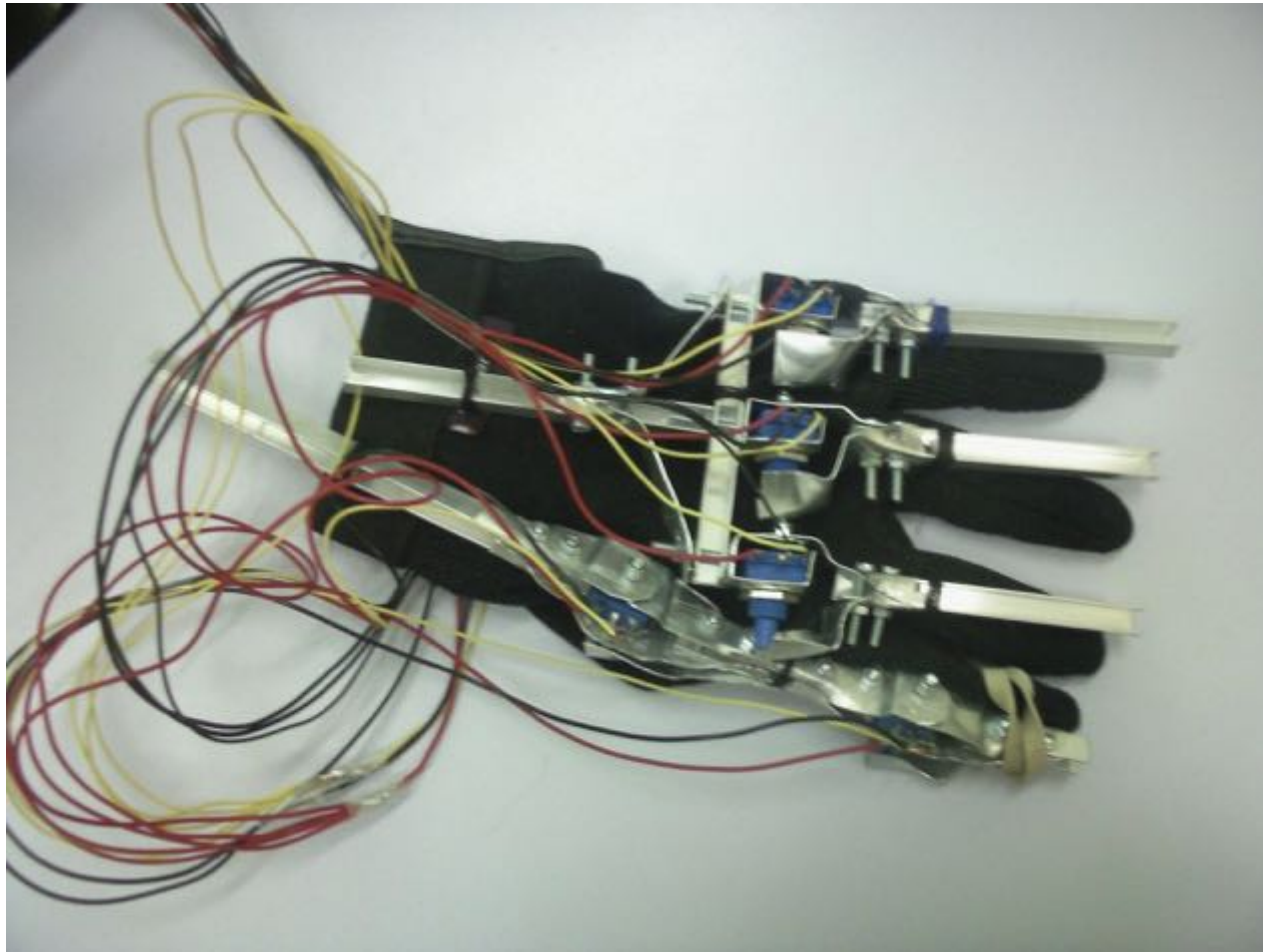


<http://www.jaronlanier.com/>

A LIRE : <http://www.jaronlanier.com/topeleven.html>

# Google cardboard





gant de captation (élève ingénieur cnam paris, 2010)

paru en 2016

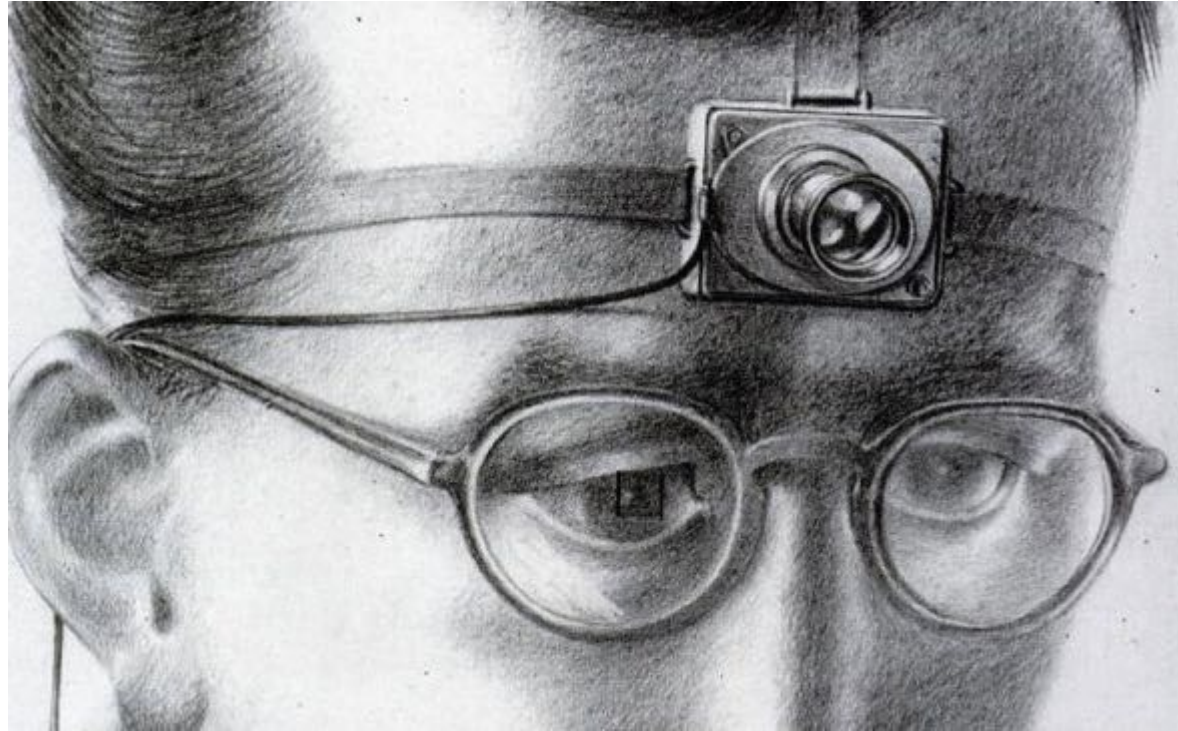
+ le traité de la RV  
Fuchs et al.



Sortie nov. 2020  
30 €







V. Bush. "As we may think" 1945



**D. Engelbart (1962)**

**Augmenting human  
intellect (...)**

**ABSTRACT**

---

This is an initial summary report of a project taking a new and systematic approach to improving the intellectual effectiveness of the individual human being. A detailed conceptual framework explores the nature of the system composed of the individual and the tools, concepts, and methods that match his basic capabilities to his problems. One of the tools that shows the greatest immediate promise is the computer, when it can be harnessed for direct on-line assistance, integrated with new concepts and methods.

| <b>Augment:</b>                           | <b>Approach</b>                    | <b>Technology</b>   | <b>Applications</b>  |
|---|------------------------------------|---|--|
| Users                                     | Wear devices on the body           | VR helmets<br>Goggles<br>Data gloves  | Medicine<br>Field service<br>Presentations                 |
| Physical objects                          | Imbed devices within objects       | Intelligent bricks<br>Sensors, receptors<br>GPS, electronic paper                   | Education<br>Office facilities<br>Positioning              |
| Environment surrounding objects and users | Project images and record remotely | Video cameras, Scanners<br>Graphics tablets<br>Bar code readers<br>Video Projectors | Office work<br>Film-making<br>Construction<br>Architecture |

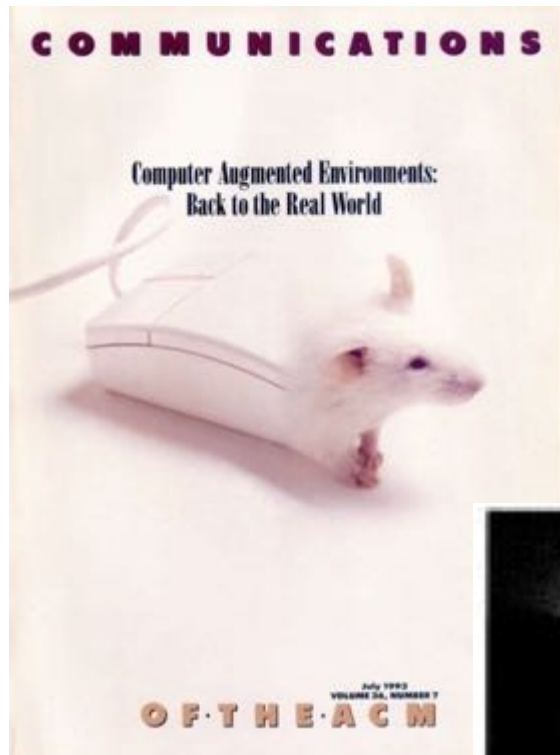
**Figure 1: Examples of augmented reality approaches, with relevant technologies and applications**

W.E. Mackay. Augmented reality : Linking real and virtual worlds. A new paradigm for interacting with computers. Proc. ACM AVI'1998

Head-up display (HUD) = affichage tête haute



[https://fr.wikipedia.org/wiki/Affichage\\_tête\\_haute](https://fr.wikipedia.org/wiki/Affichage_tête_haute)



CACM July 1993



P. Wellner

W. Mackay  
et al.

# Le stylo Anoto et les cahiers augmentés

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**Video: Pixel-perfect precision writing on 4K tablet**

Watch Neymar use electronic pen for digital writing to perform unprecedented level of precision on the Panasonic 20-inch 4k tablet

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Whitepaper

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**\$792,242 Spent Every Second on Processing Traditional Documents Worldwide**

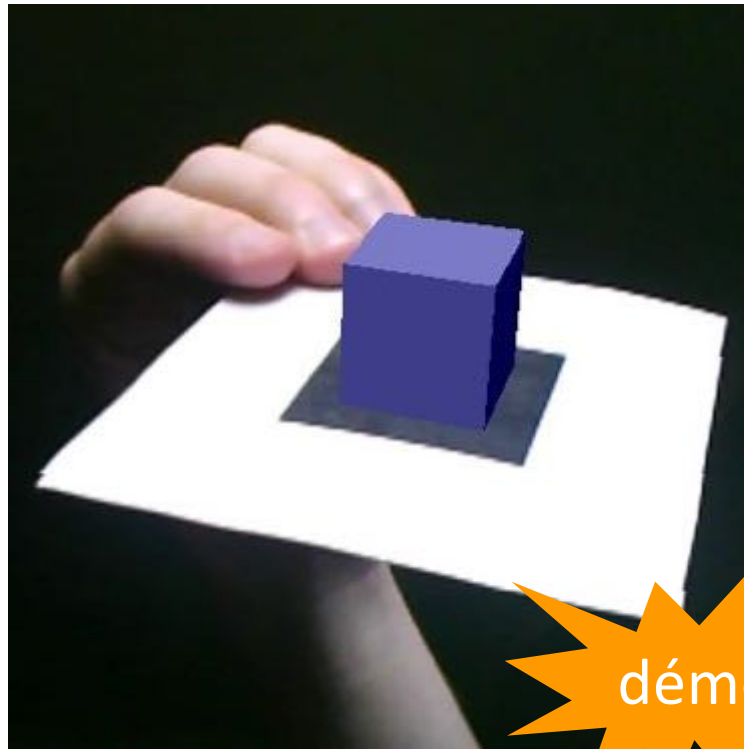


(a)



(b)

1997 : S. Feiner et al. : Columbia touring machine



**ARToolkit**

**H. Kato + U. Washington + U. Canterbury, >1999**



## Thèse d'Areti Damala (FT R&D, 2006-8) : RA visuelle



The evaluation of the mobile AR guide had many inherent difficulties. The first one is related with a major issue observed in the field of AR, where user studies are still clearly underutilized. Gabbard and Swan report that in a total of 1,104 articles on AR recessed, only 2% included a user based study [11]. This creates

## Thèse de Fatima Kaghat (2011-14) : RA sonore



machines ≠ sculptures ?

couplage restitution stéréo et captation des mouvements

utilisation d'AR toolkit pour la captation



## 2014 : Google Glass



- + Aura (Optivent)
- + SpaceGlasses (Meta)
- + ReconJet (ReconInstrument)
- + Wrap 1200 DXAR (Vuzix)

# Intel "RealSense » en 2014

intel Menu

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France (Français) Connexion

## Utilisation des sens

La technologie Intel® RealSense™ va bouleverser la façon dont vous communiquez avec vos appareils et avec le monde qui vous entoure. Comment ? En apportant des interactions plus immersives. La reconnaissance des gestes et le scan 3D ne sont qu'un début. La technologie Intel® RealSense™ permet de travailler et de jouer comme jamais, car les appareils peuvent vous voir, vous entendre et vous sentir.

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Intel® RealSense™ Nouveau seuil de réalisme Détails Produits Dévelop

Accepter les co

<http://www.intel.fr/content/www/fr/fr/architecture-and-technology/realsense-overview.html>

en 2016 : les premiers produits



## Introducing Intel® RealSense™ Smartphone Developer Kit

By Miao W. (Intel), Added February 22, 2016

Translate



Forum

Intel® F  
SDK

During CES 2016 in Las Vegas in January, Intel announced the Intel RealSense Smartphone Developer Kit (SDK), an Android device with embedded Intel® RealSense™ Camera ZR300 and supports Google\* Project Tango\* developer ecosystem. Currently the developer kit is open for [reservation](#).

The Intel® RealSense™ Smartphone Developer Kit is powered by the Intel® Atom™ x7-Z8700 SoC (formerly Cherry Trail), which features the 14nm Intel Architecture technology with 4 Cores / 4 Threads and Gen 8 Intel® HD Graphics, and the industry-leading Intel® RealSense™ Camera ZR300. The Developer Kit includes a 6" QHD (2560x1440) display. The device comes with 2GB of memory and 64GB of internal storage. It includes an 8MP rear camera and a 2MP front-facing camera. Figure 1 and Figure 2 show the front and back views of the Developer Kit, respectively.



## Lenovo Phab 2 Pro

The Lenovo Phab 2 Pro is the world's first Tango-enabled smartphone.

[LEARN MORE](#)

[http:// get.google.com/tango/](http://get.google.com/tango/)



# [Réalité augmentée] En réponse à Apple, Google annonce ARCore et arrête Tango

JULIEN BERGOUNHOUX | RÉALITÉ AUGMENTÉE, GOOGLE, SMARTPHONE |  
PUBLIÉ LE 30 AOÛT 2017 À 11H12

TWITTER

FACEBOOK

LINKEDIN

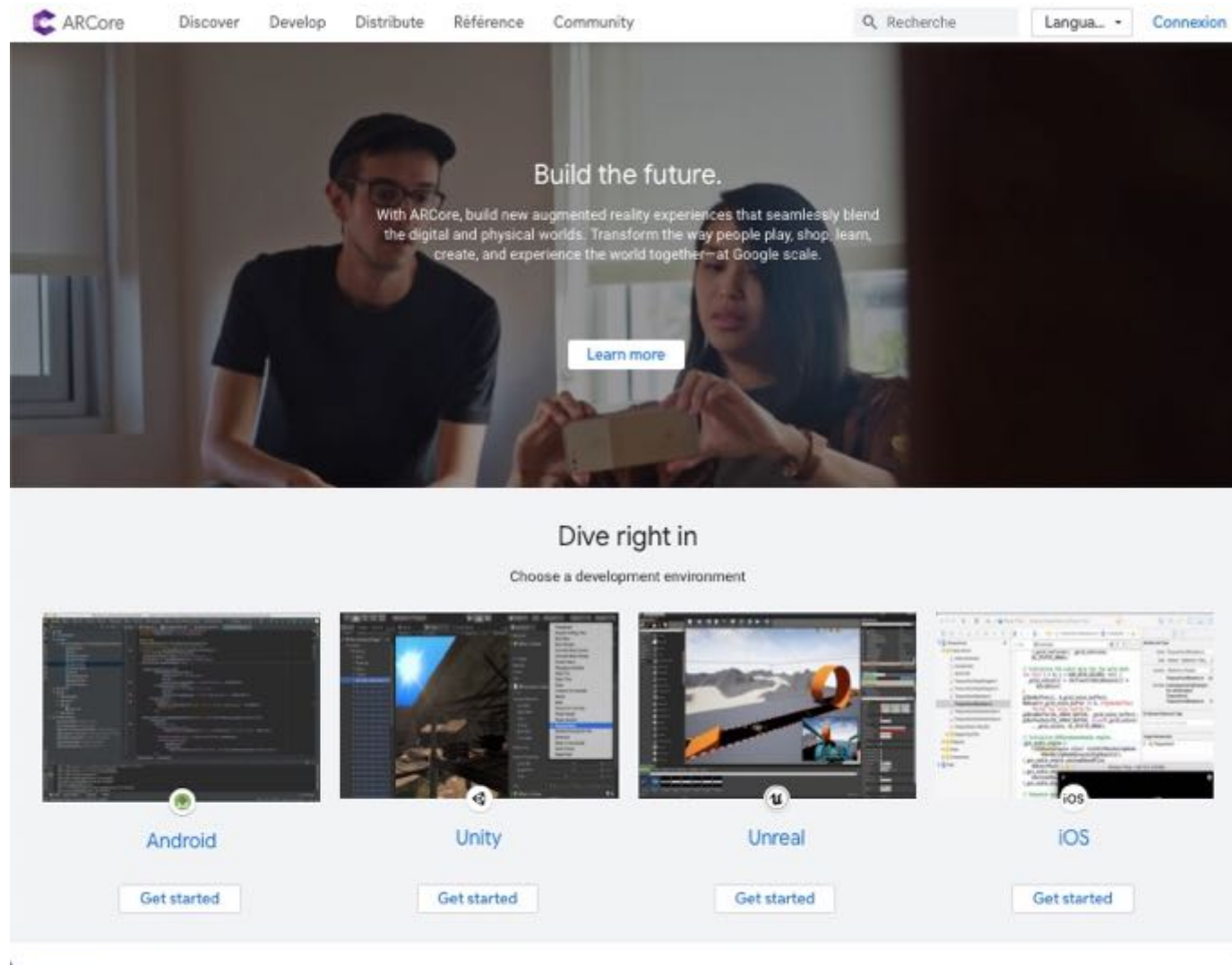
GOOGLE+

EMAIL

**VIDÉO** **ANALYSE** A deux semaines de la sortie des premières applications en réalité augmentée sur iPhone, Google annonce ARCore, un kit de développement logiciel pour démocratiser la réalité augmentée sur Android. La plate-forme Tango, sur laquelle il travaillait depuis 3 ans, est abandonnée au profit de cette nouvelle approche. Un changement de stratégie brutal forcé par la perspective de millions d'iPhone compatibles avec ARKit, alors que les ventes smartphones embarquant Tango ne se comptaient qu'en milliers.

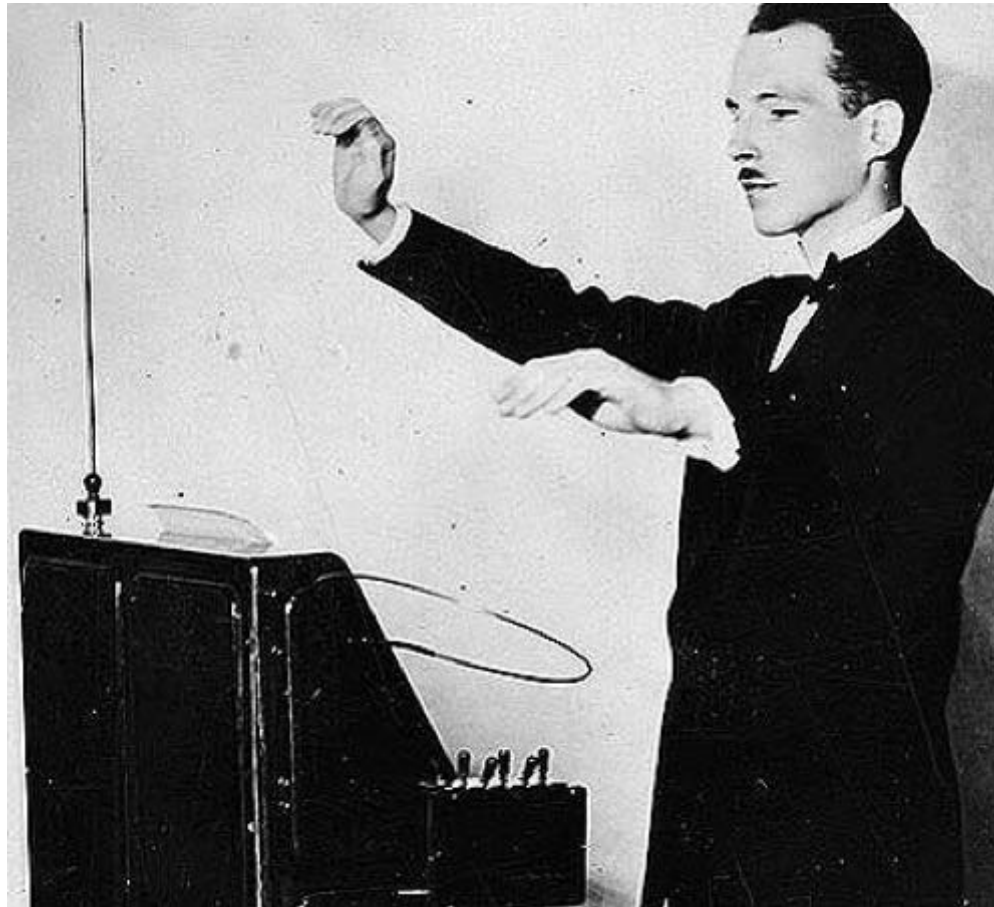


Et en 2019 : ARCore opérationnel 😊



=> voir la rubrique "discover" du site

# (5) Les objets malins



Theremine (1917)

Deja une industrie



Choose your robot type:

- Vacuum Cleaning
- Floor Washing
- Shop Sweeping
- Pool Cleaning
- Gutter Cleaning
- Virtual Visiting**



**iRobot® ConnectR™ Virtual Visiting Robot**

**Stay close to those you love – no matter where you are!**

Don't miss out on special moments at home even when you are away. The iRobot ConnectR is a fun new way to see, talk to and interact with your loved ones, friends and pets – when you can't be there in person. Combining the latest in Internet communications and robot technology, ConnectR lets you virtually visit with loved ones, relatives and pets anytime you wish – seeing, hearing and interacting with them in their home as if you were there in person.



- Participate in family moments even though you're working late
- On a business trip? Read your kids a story and see their faces light up
- Join the fun from near or far
- Throw a party from a thousand miles away
- Tell Fido he's a "good boy" even while you're on vacation

**About ConnectR**

- [How it Works](#)
- [ConnectR FAQs](#)
- [ConnectR Sign-up](#)



# Les « phidgets » (S. Greenberg, C. Fitchett, U. Calgary, 2001)

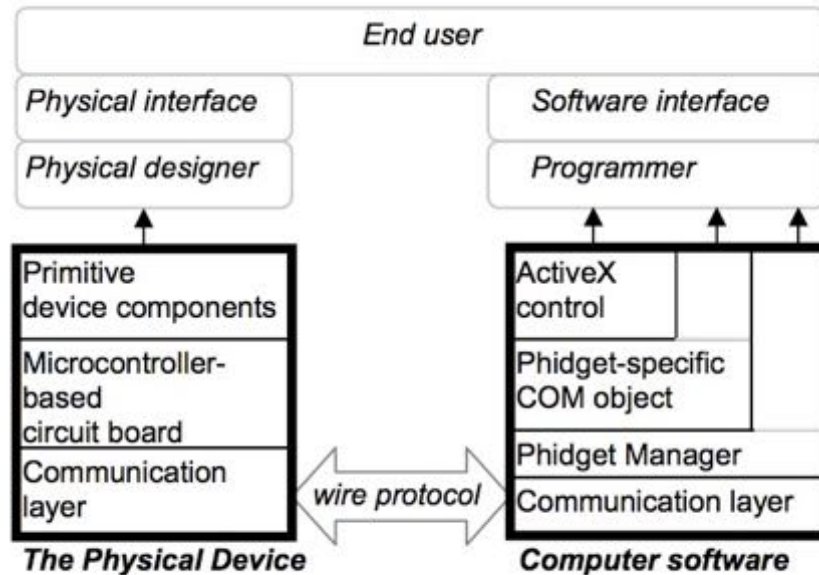


Figure 5. Phidget Architecture

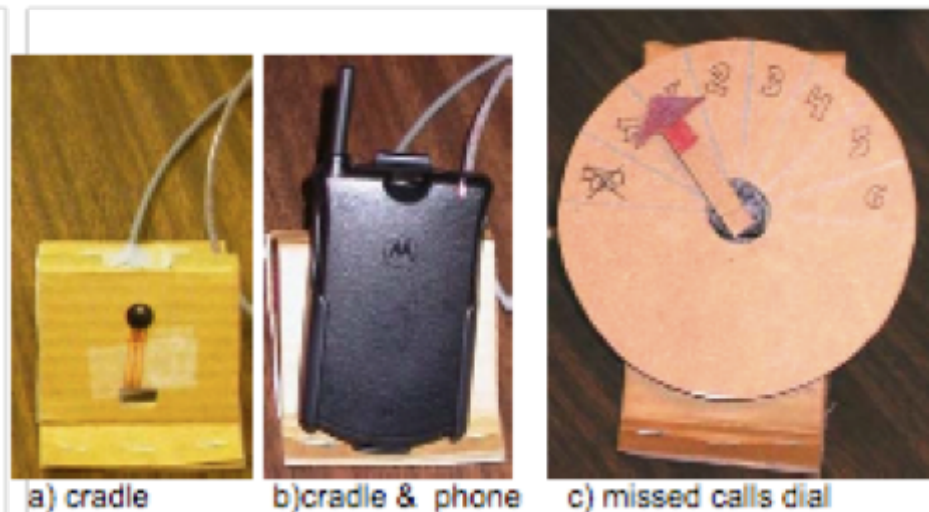
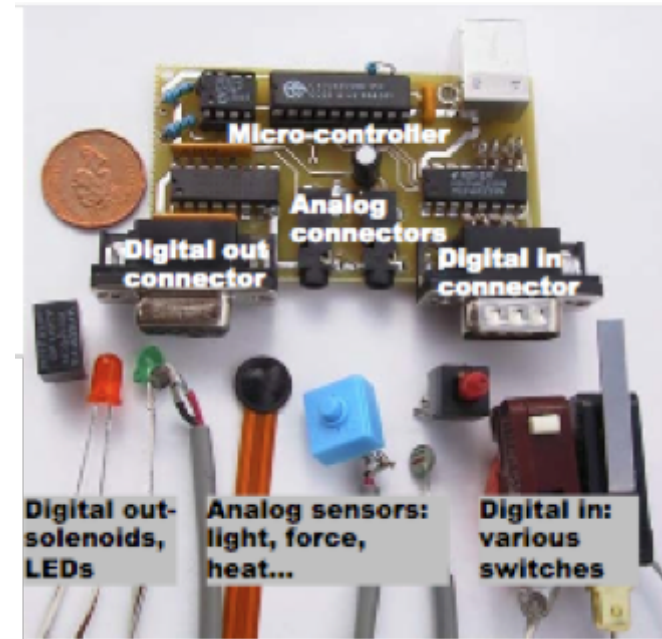


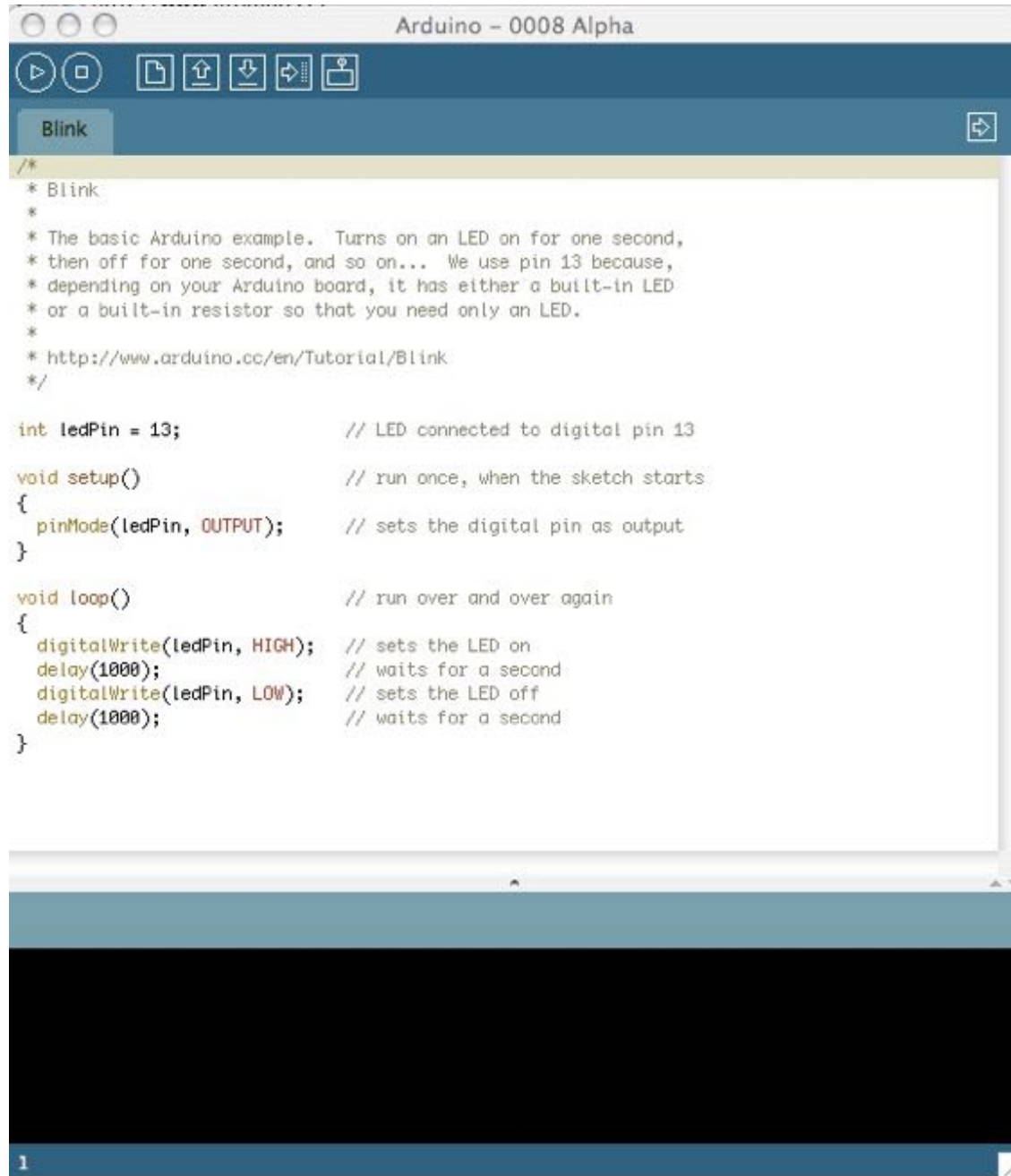
Figure 11: Phidget Eyes: closed, open & lit, fully open

## La carte ARDUINO



(Science et vie junior - février 2012)

# « blink » : le Hello world de l'Arduino

The image shows a screenshot of the Arduino IDE interface. The window title is "Arduino - 0008 Alpha". The top toolbar contains icons for play, stop, save, upload, download, and refresh. Below the toolbar, a tab labeled "Blink" is active. The main text area contains the following C++ code:

```
/*
 * 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
 */

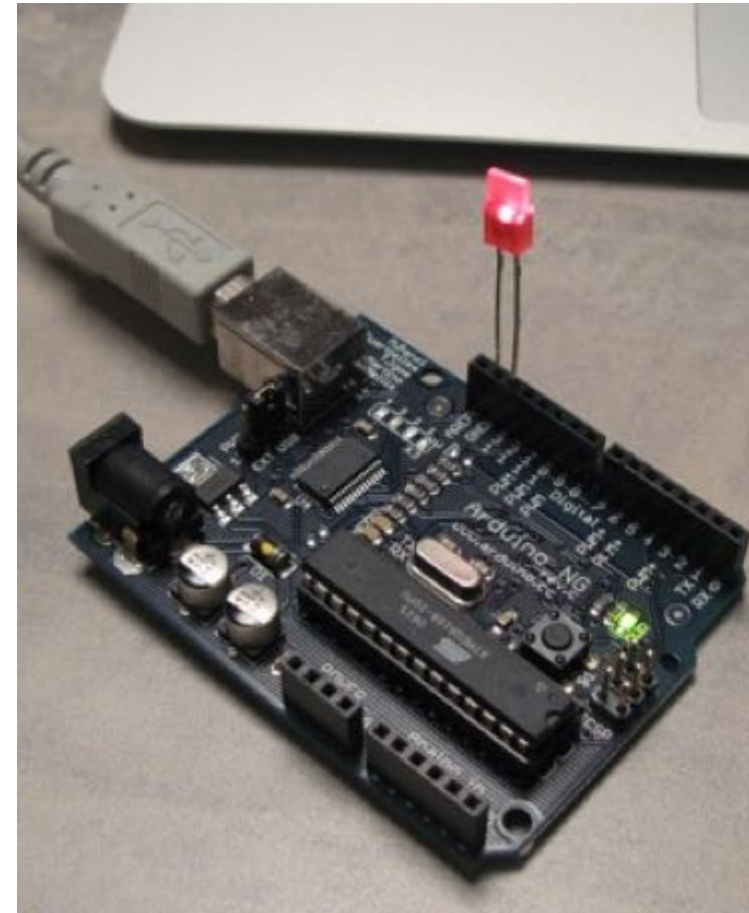
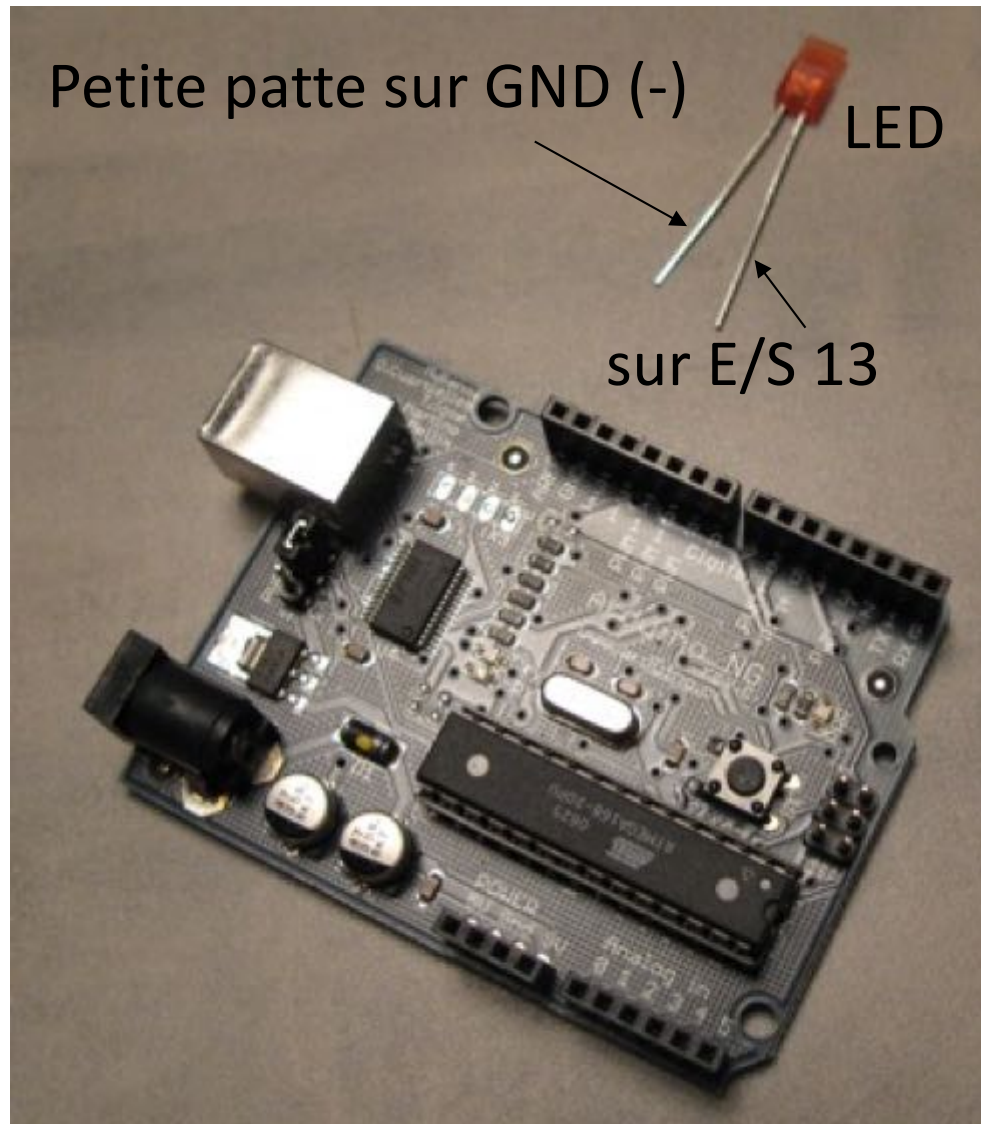
int ledPin = 13;          // LED connected to digital pin 13

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
}
```

The bottom of the IDE shows a dark area for the serial monitor, which is currently empty. A small number "1" is visible in the bottom-left corner of the IDE window.

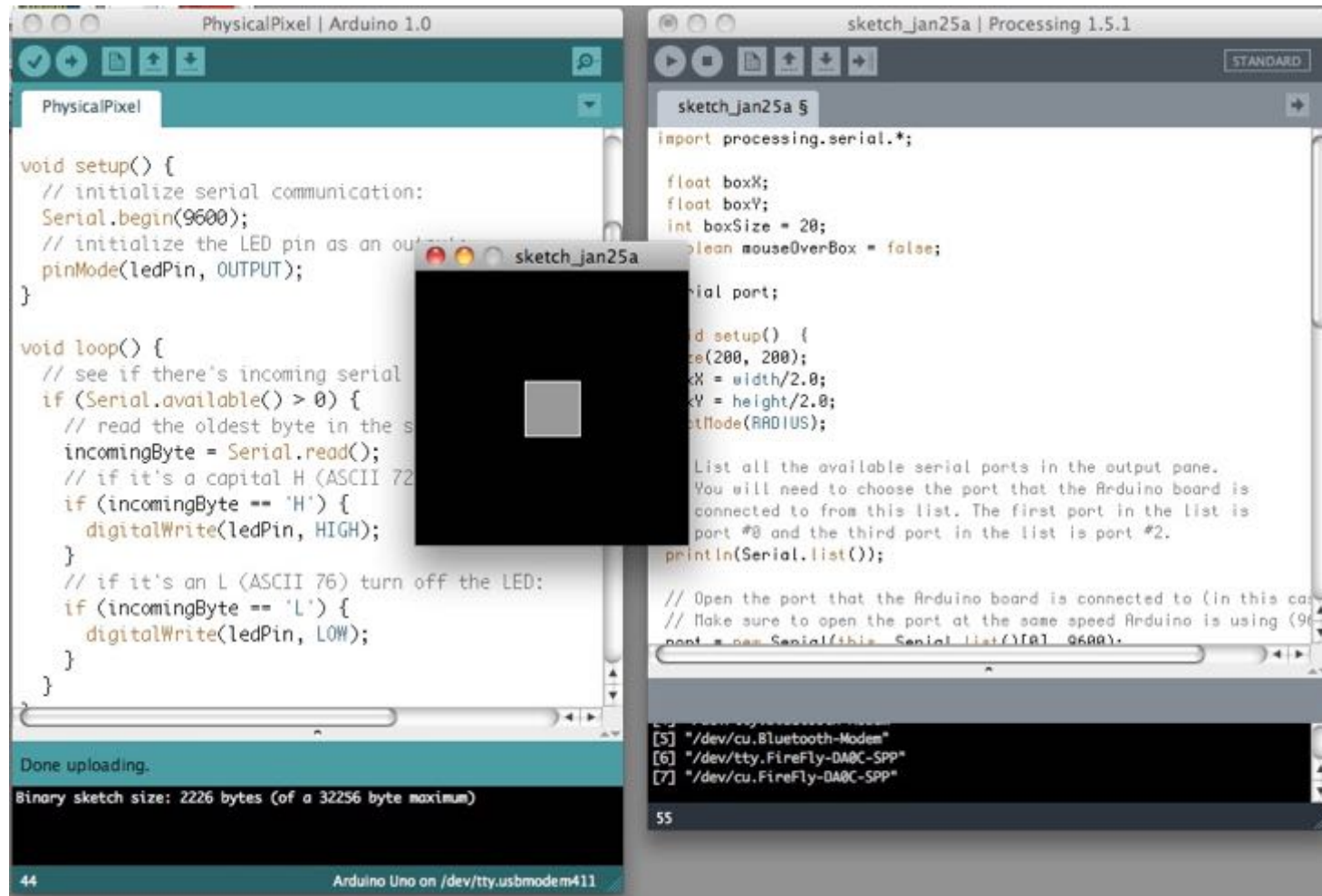
# Blink : le montage



Fiat lux ...



Dialogue avec une application processing (liaison série) :  
La demo "physical pixel" de exemples->communication



=> à suivre cours de J. Dupire

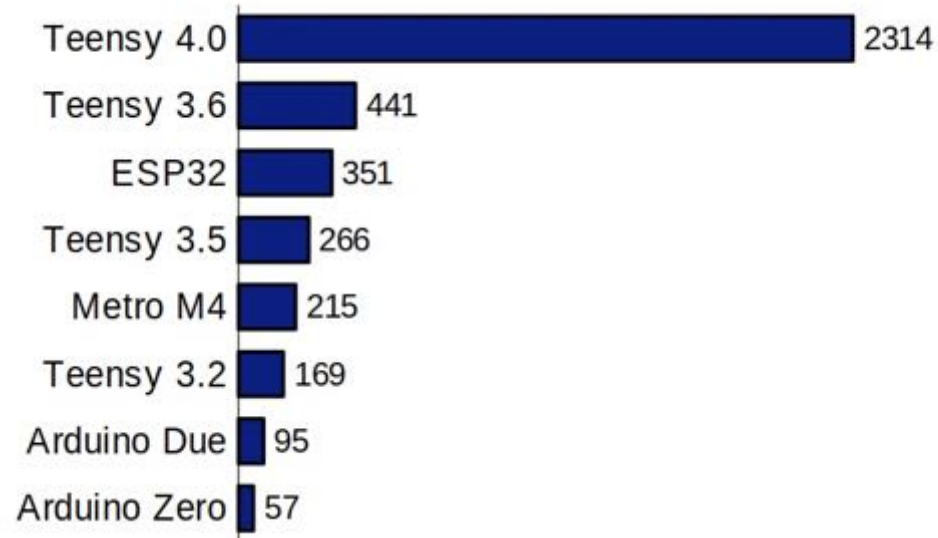
# PUB

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- [cketter's Add-On for](#)
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- [fee Roaster by Catskull](#)
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- [To 100th](#)
- [Arduino Serial rformance Display](#)
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- [dapter for](#)
- [board for](#)
- nives**
- [2019 \(1\)](#)
- [19 \(6\)](#)
- [:2019 \(4\)](#)
- [9 \(5\)](#)
- [14\)](#)

Teensy 4.0 [is now available](#).



Teensy 4.0 features a 600 MHz Cortex-M7 processor, dramatically faster than prior Teensy models & other microcontrollers!



<https://www.pjrc.com/teensy-4-0/>

# "Physical computing" ?

Physical computing

From Wikipedia, the free encyclopedia

- Have questions?

[Find out how to ask questions and get answers.](#) •Jump to: [navigation](#), [search](#)

Physical computing, in the broadest sense, means building interactive [physical systems](#) by the use of [software](#) and [hardware](#) that can sense and respond to the [analog](#) world. While this definition is broad enough to encompass things such as smart automotive traffic [control systems](#) or factory [automation processes](#), it is not commonly used to describe them. In the broad sense, physical computing is a creative framework for understanding [human beings'](#) relationship to the [digital](#) world. In practical use, the term most often describes handmade [art](#), design or [DIY](#) hobby projects that use [sensors](#) and [microcontrollers](#) to translate analog input to a [software system](#), and/or control [electro-mechanical](#) devices such as [motors](#), [servos](#), [lighting](#) or other hardware.

(Greenberg, UIST'01)

## INTRODUCTION

In the last decade, various movements embraced human-computer interface designs that include physical user interfaces augmented by computing power. These include *ubiquitous computing* and *calm technology* [15], *pervasive computing* [1], *tangible user interfaces* [7], *information appliances* [12] and *context-aware computing* [3].

Researchers in these areas have demonstrated many simple but exciting examples of physical user interfaces. Ishii and

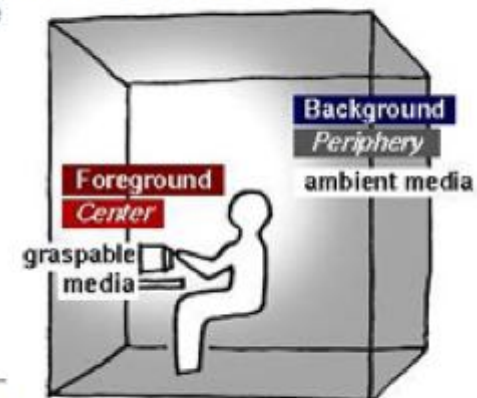
Physical Computing is an approach to learning how humans communicate through computers that starts by considering how humans express themselves physically. In this course, we take the human body as a given, and attempt to design computing applications within the limits of its expression.

(Interactive Telecom. Program ITP NYU)

# Les interfaces tangibles

**Tangible Bits** is our vision of Human Computer Interaction (HCI) which guides our research in the Tangible Media Group. People have developed sophisticated skills for sensing and manipulating our physical environments. However, most of these skills are not employed by traditional GUI (Graphical User Interface). Tangible Bits seeks to build upon these skills by giving physical form to digital information, seamlessly coupling the dual worlds of bits and atoms.

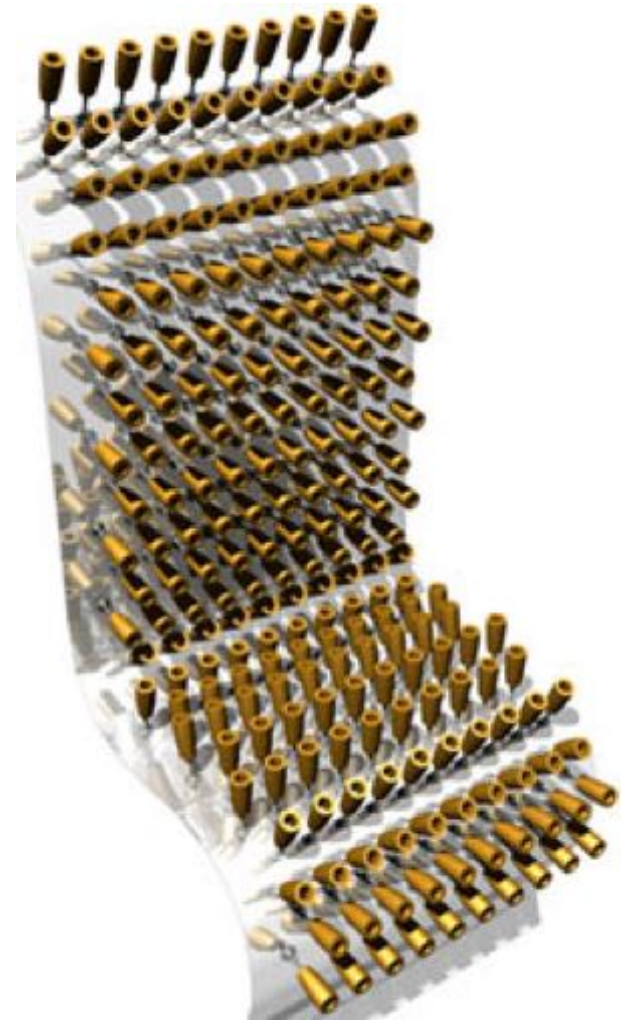
Guided by the Tangible Bits vision, we are designing "tangible user interfaces" which employ physical objects, surfaces, and spaces as tangible embodiments of digital information. These include foreground interactions with graspable objects and augmented surfaces, exploiting the human senses of touch and kinesthesia. We are also exploring background information displays which use "ambient media" – ambient light, sound, airflow, and water movement. Here, we seek to communicate digitally-mediated senses of activity and presence at the periphery of human awareness. The goal is to change the "painted bits" of GUIs (Graphical User Interfaces) to "tangible bits," taking advantage of the richness of multimodal human senses and skills developed through our lifetime of interaction with the physical world.



drawing: Hiroshi Ishii

[Tangible Bits full paper presented at CHI 97](#)

Ex. de projet de l'équipe : super cilia skin

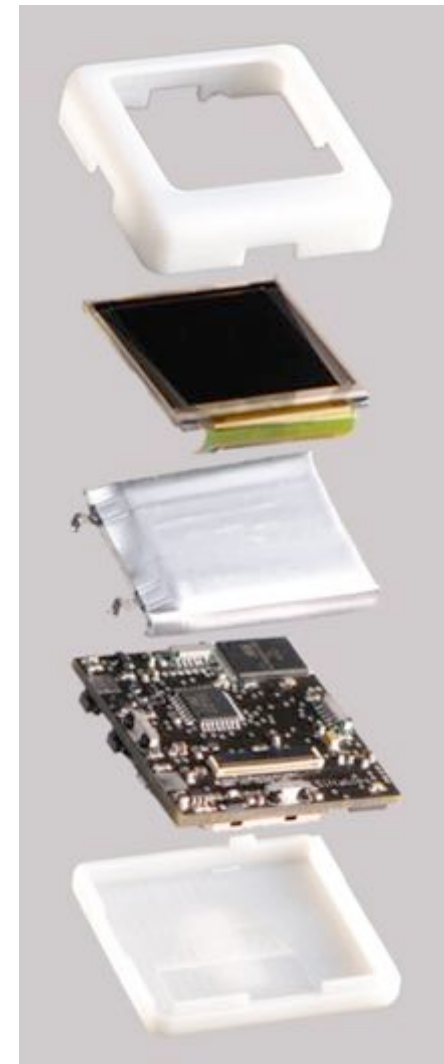
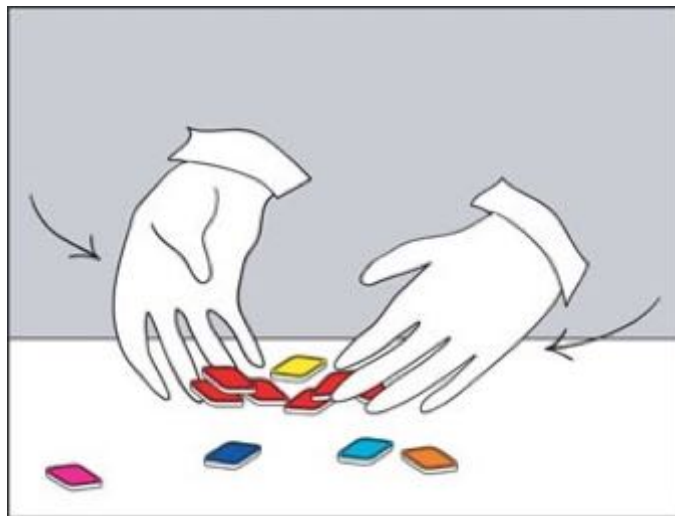
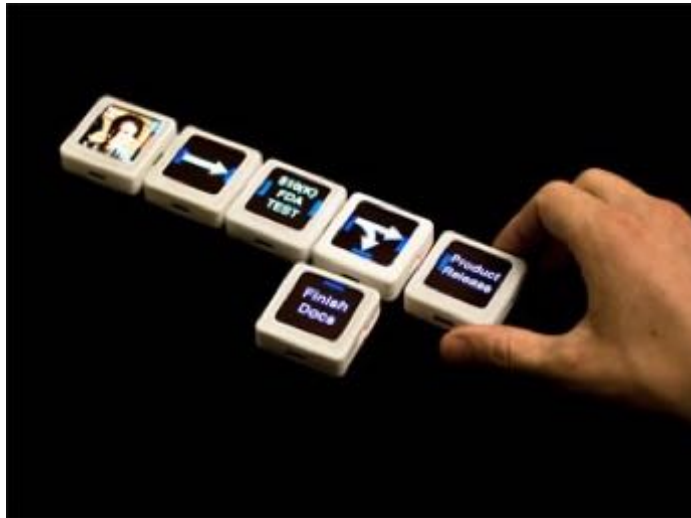


Ex : projet inFORM (Leithinger, Follmer, Ishii)



video

# Le projet « siftables » (David Merril, MIT, 2007)



<http://web.media.mit.edu/~dmerrill/siftables.html>

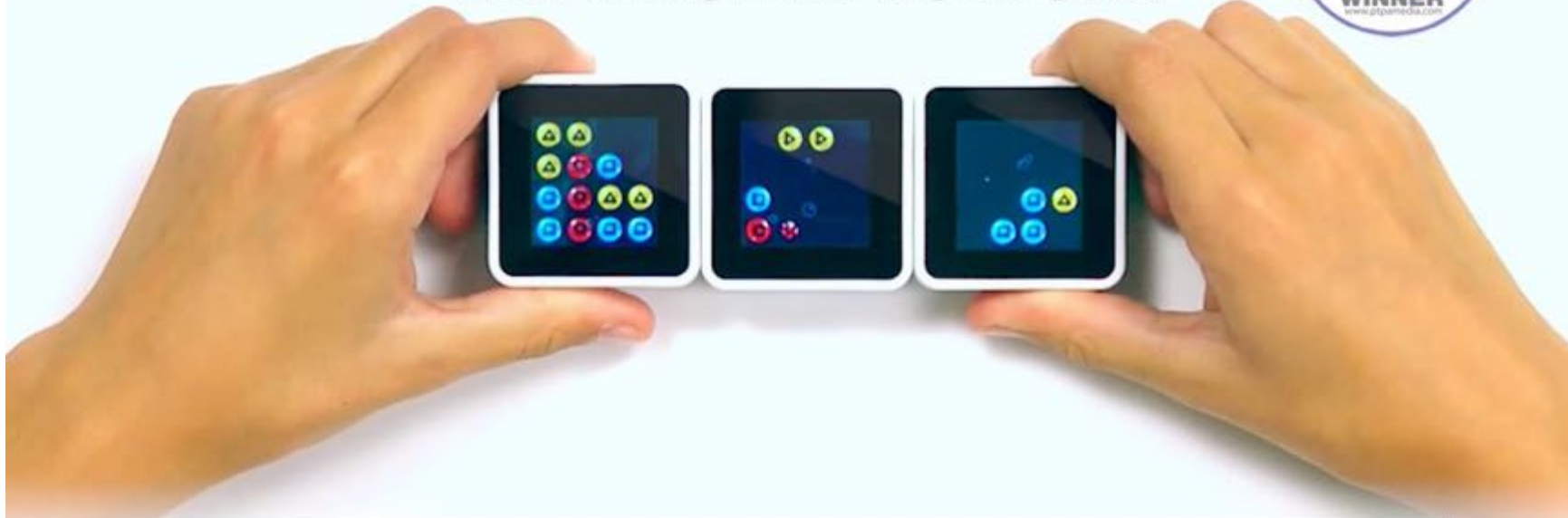


LOGIN CART

Sifteo Cubes Intelligent Play Games About Us Press Shop

# Sifteo Cubes

award-winning interactive game system



“thought possible.”

San Francisco Chronicle

“a clever new way for children”





projet "fat and furious" Master ENJMIN 2013



## So long, thank you, we're still here

We'll cut to the chase: Sifteo has been acquired by [3D Robotics](#)! We're really excited about it; we will continue to support Sifteo Cubes and Sifteo users; and we are so grateful to our customers and supporters around the world. *Thank you.*



*handbuilt prototypes from our MIT days*

When we (Dave and Jeevan) started Sifteo in 2009, we knew we could deliver magical versions of everyday objects - that we could use the latest in computing and sensors to create new interactions that were more natural, more human, and just better than what currently existed.

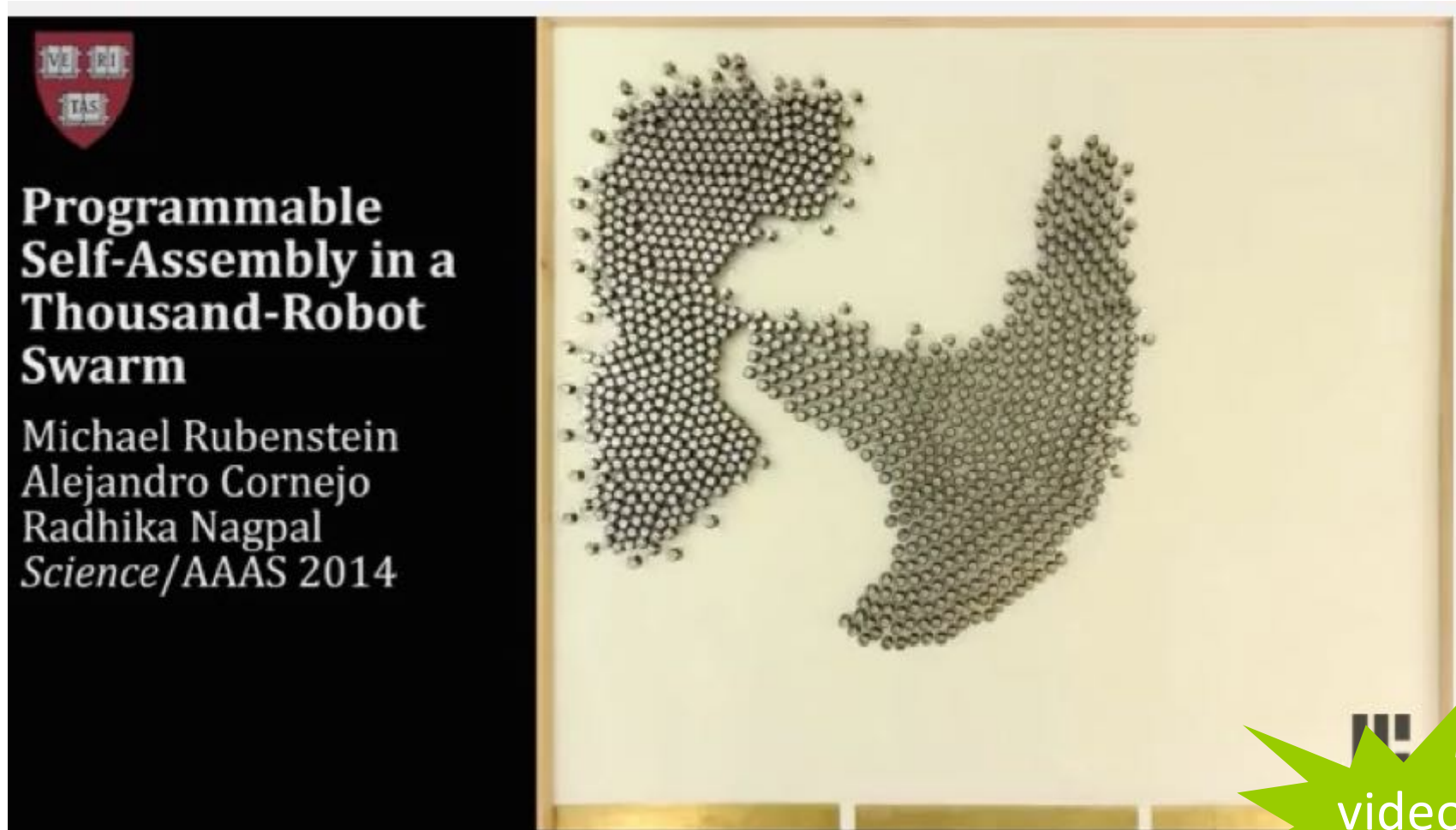
# zoids



video

<https://aviz.fr/swarmui>

à étudier ?



<https://www.youtube.com/watch?v=G1t4M2Xnlhl>