

# DIGITAL SYNESTHESIA



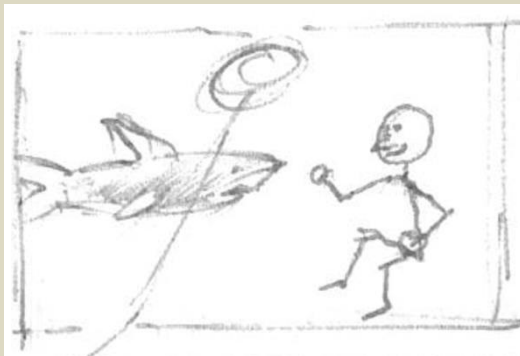
USING MOBILE TECHNOLOGY TO INTERACT WITH OUR WORLD

PHD PROPOSAL BY:  
SANTIAGO ALFARO

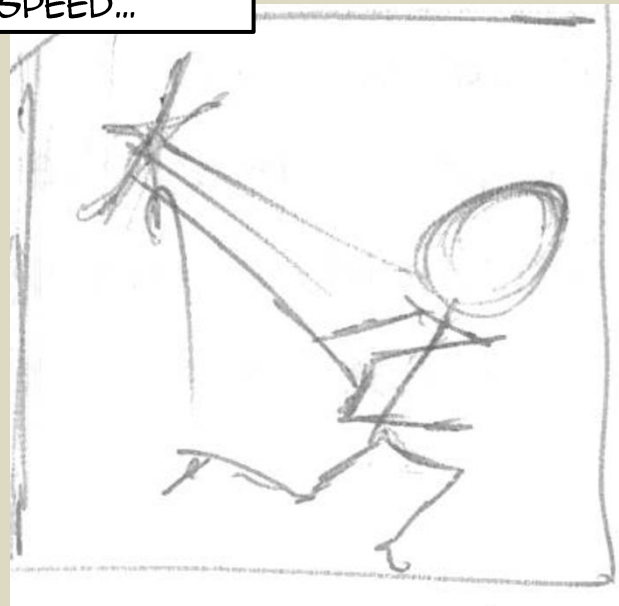
COMMITTEE:  
V. MICHAEL BOVE JR.  
JOSEPH PARADISO  
KEVIN SLAVIN

HUMANS HAVE  
DREAMT OF  
GOING PAST  
OUR PHYSICAL  
CAPABILITIES  
LIKE...

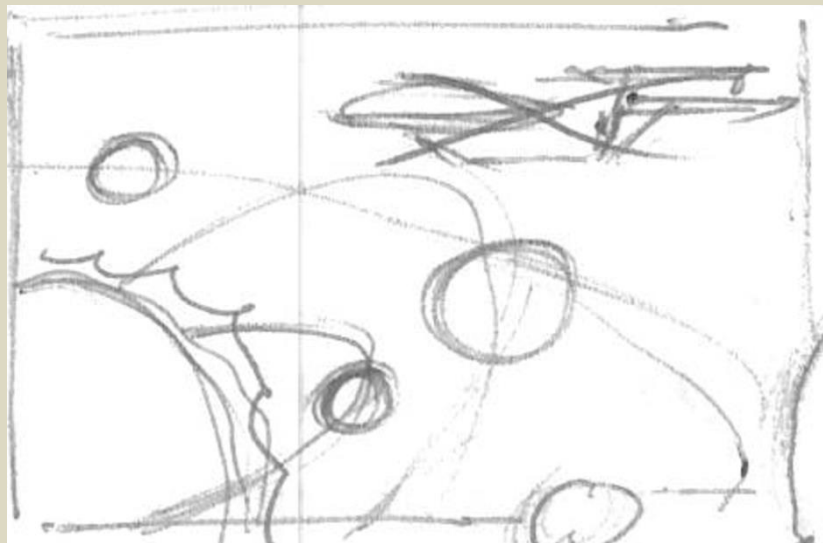
... BREATHING UNDER  
WATER...



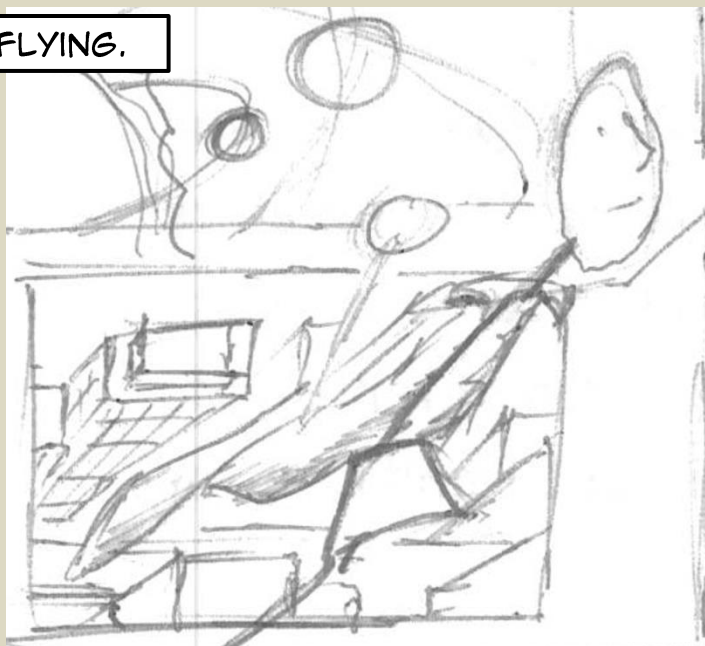
... SPEED...



... GOING TO SPACE...

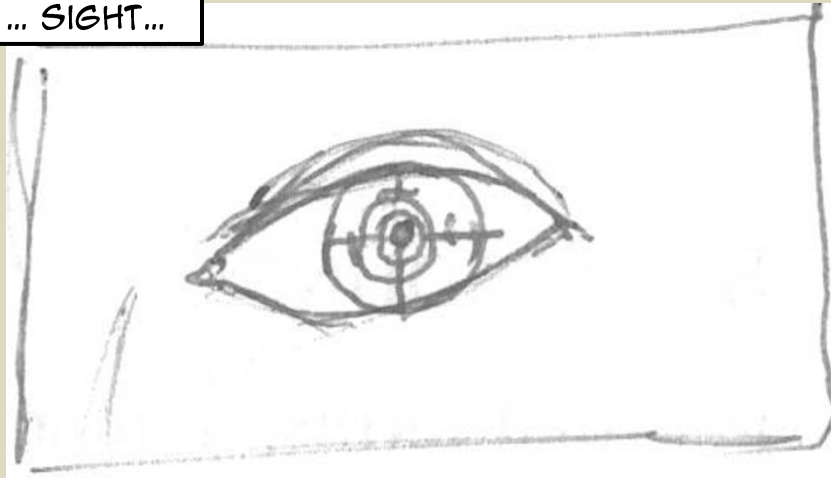


... OR FLYING.



OTHER DREAMS  
ARE ABOUT  
OUR SENSES...

... SIGHT...



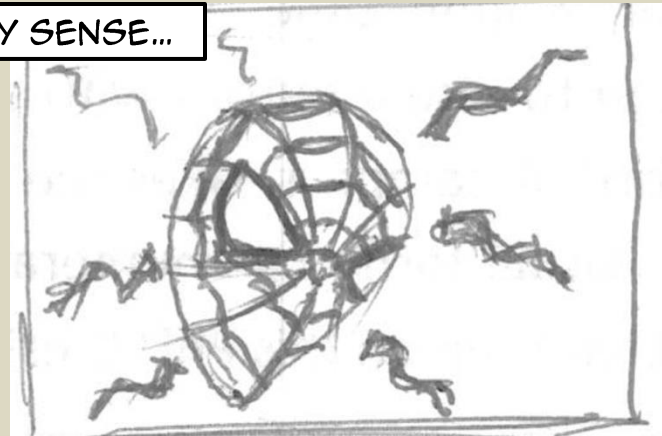
... HEARING...



SOME ARE  
ABOUT SENSES  
WE DON'T  
POSSESS



... SPIDEY SENSE...



... A DISTURBANCE  
IN THE FORCE.

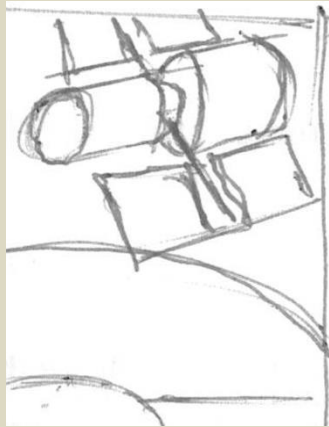
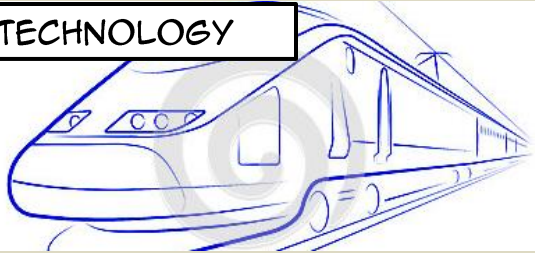




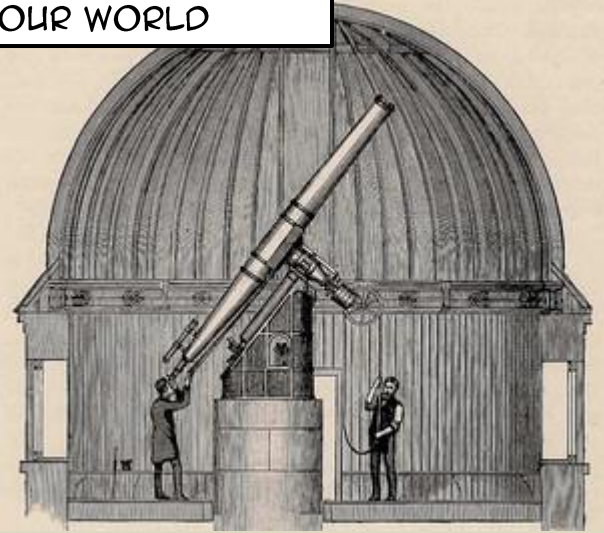
WE HAVE  
REACHED SOME  
DREAMS



WITH TECHNOLOGY



AND  
UNDERSTANDING  
OUR WORLD



# Intro what

to the can be sensed in the

UV LIGHT

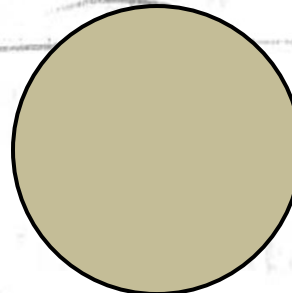
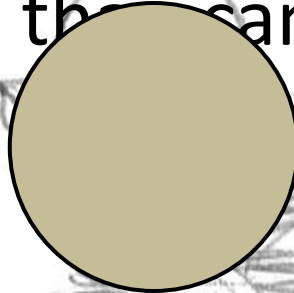
IR RADIATION

MAGNETIC  
WAVES

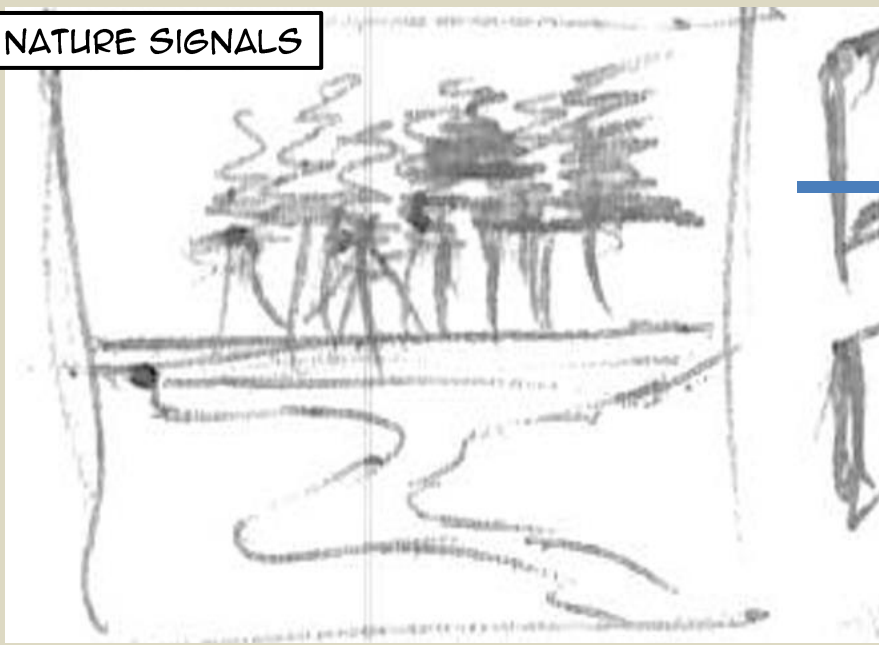
WIFI

RADIO

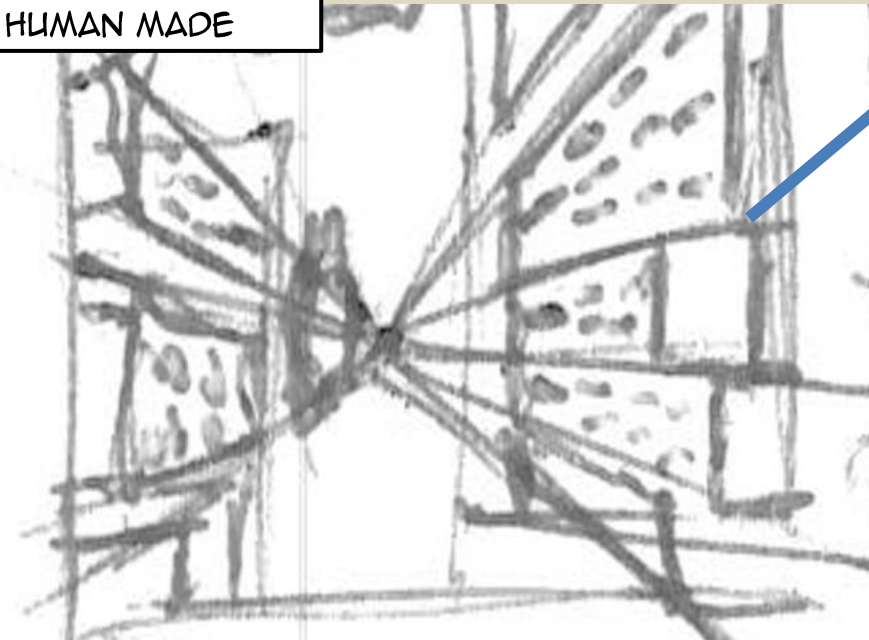
POLLUTION



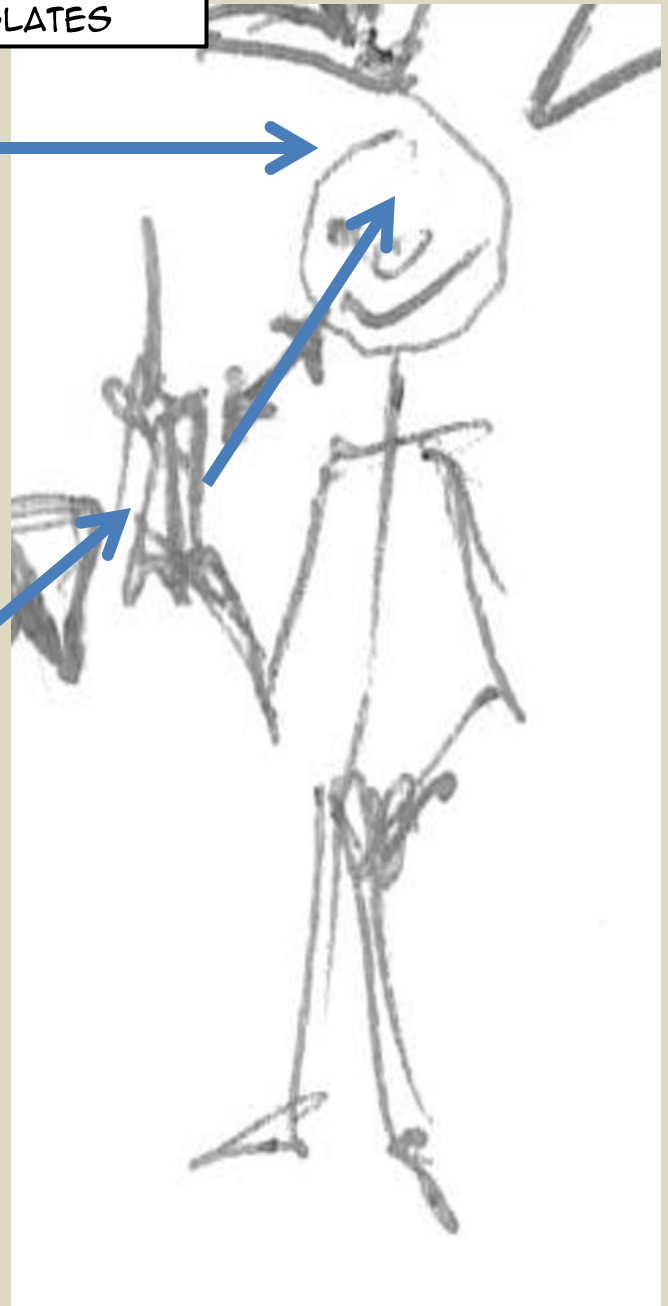
NATURE SIGNALS



HUMAN MADE



MOBILE DEVICE  
TRANSLATES



# Intro - why

- Physical connection to the world by-pass device and cognition.

BACKGROUND:

THERMAL  
INTERFACES



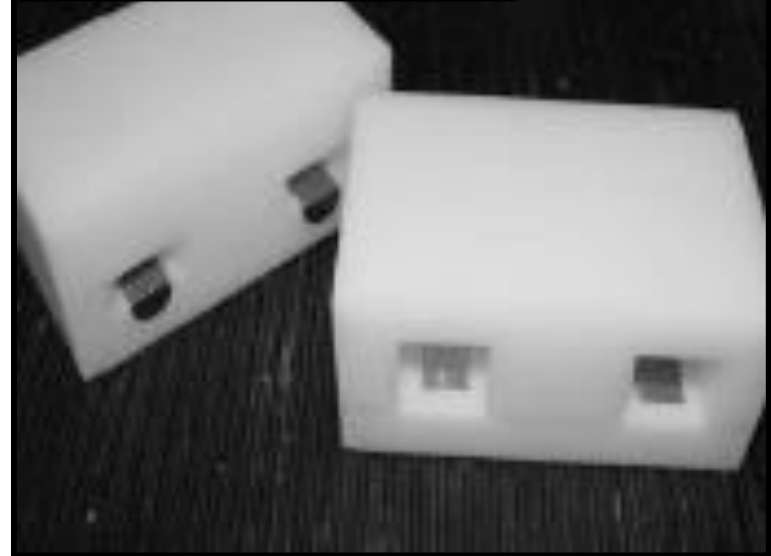


THE PRESSURE AND  
TEMPERATURE CHANGE  
OF THE FINGER WAS  
MEASURED

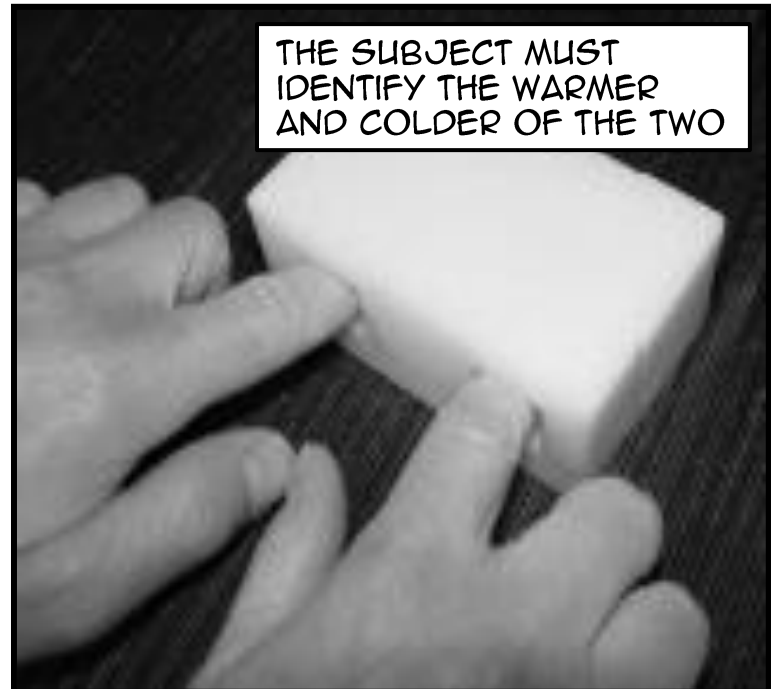
DEVELOPMENT OF THERMAL DISPLAYS AND  
UNDERSTANDING THE NATURE OF THERMAL CUES.

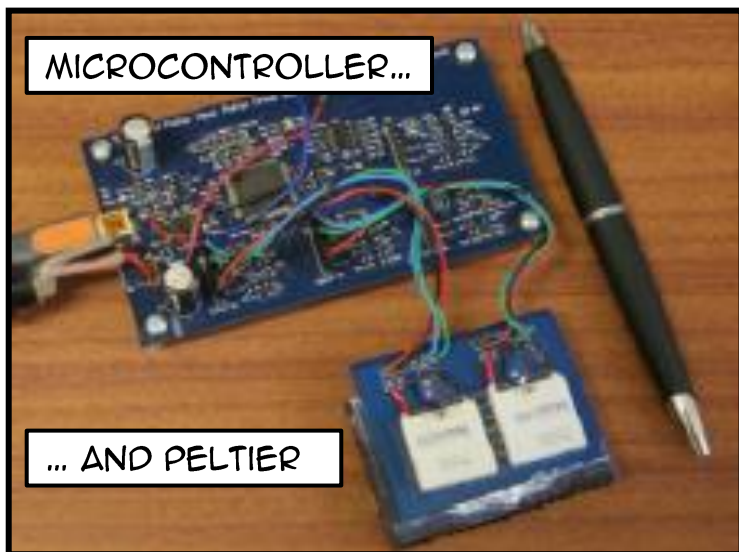
"MATERIAL DISCRIMINATION AND THERMAL PERCEPTION"  
L. A. JONES AND M. BERRIS

DIFFERENT MATERIAL ARE  
PLACED IN THE DEVICE



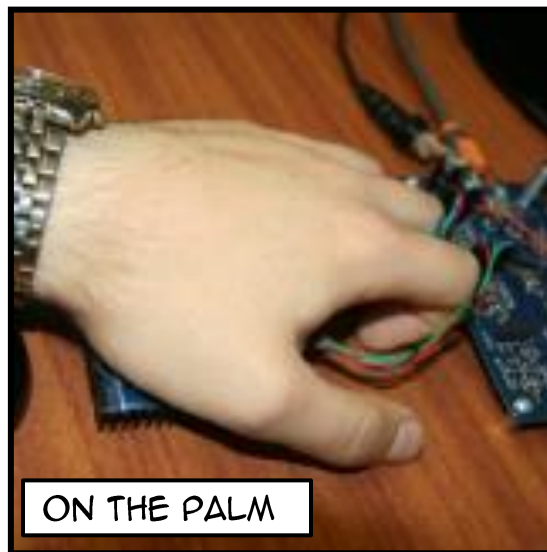
THE SUBJECT MUST  
IDENTIFY THE WARMER  
AND COLDER OF THE TWO





MICROCONTROLLER...

... AND PELTIER



ON THE PALM



ON THE ARM

USERS DETECT HOT AND COLD STIMULI PRESENTED TO THE FINGERTIPS, THE PALM AND THE ARM

TWO STUDIES. ONE STATIC INDOOR AND ONE MOBILE



THE EXPERIMENT WAS REPEATED WITH THE SUBJECTS WALKING AROUND

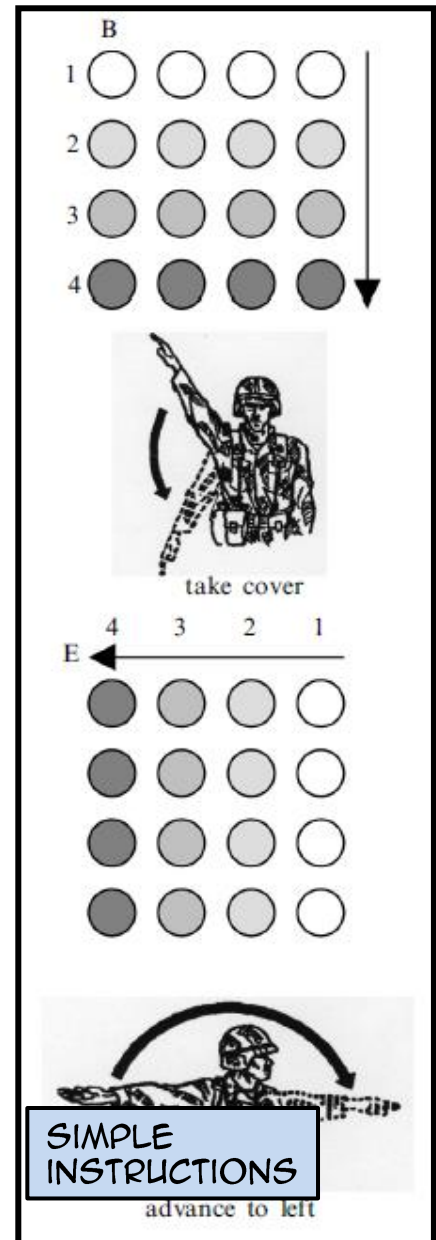
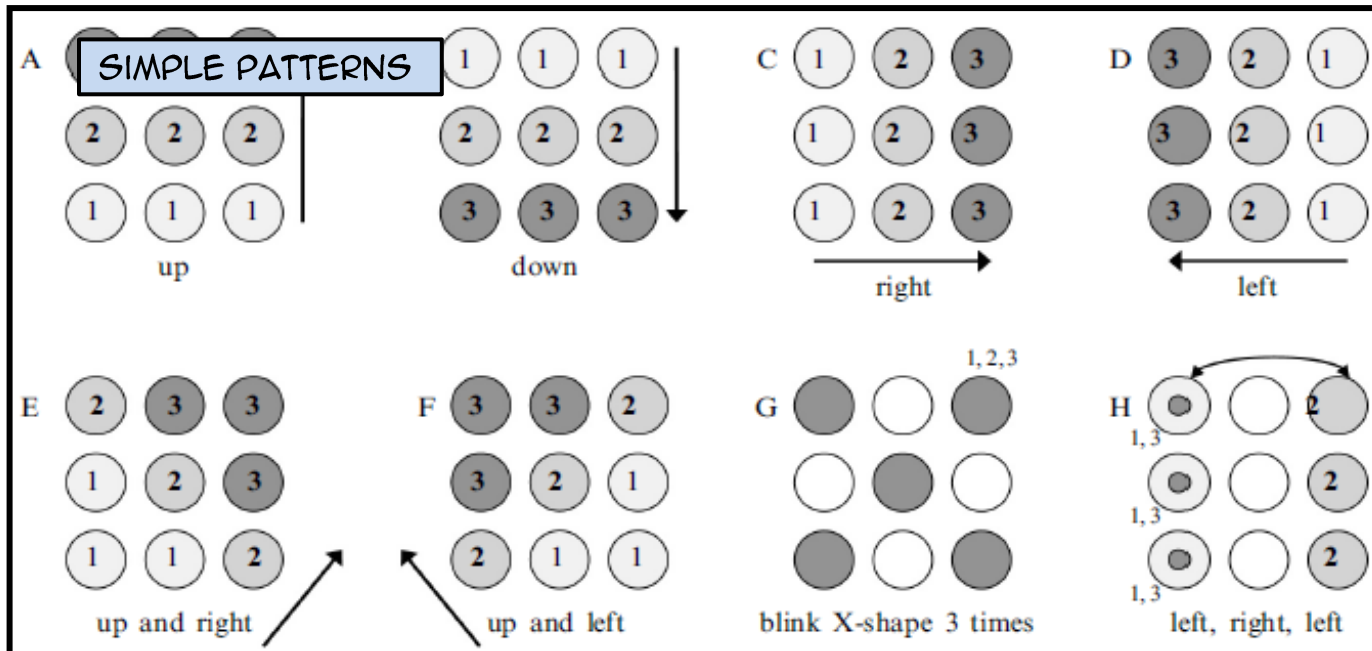
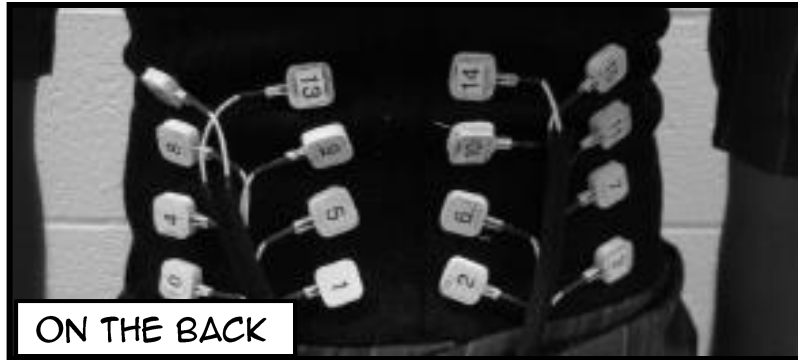


"SOME LIKE IT HOT ? THERMAL FEEDBACK FOR MOBILE DEVICES"  
G. WILSON, M. HALVEY, S. A. BREWSTER, AND S. A. HUGHES,

BACKGROUND:

VIBRATION  
INTERFACES

# HOW A TACTILE DISPLAY CAN COMMUNICATE SIMPLE INSTRUCTIONS AND COMMANDS





NO NEED FOR  
POSITIONING, THE  
SYSTEM DETECTS  
STRUCTURED  
LIGHT.

DLP (digital micro-mirror)  
projector

Time-modulated light

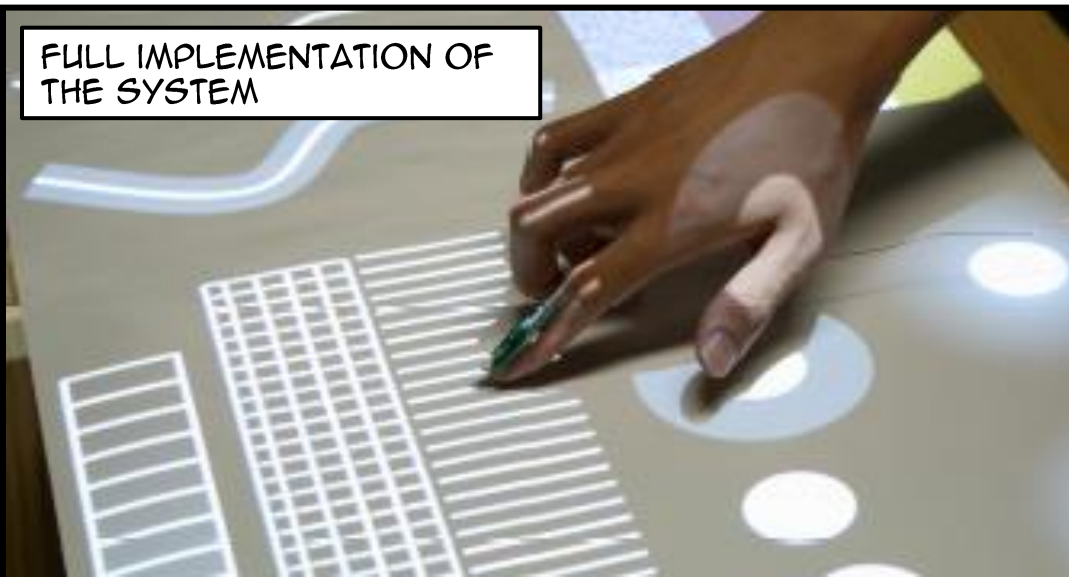
(2) tactile pattern A

(1) no tactile feedback

(3) tactile pattern B



FULL IMPLEMENTATION OF  
THE SYSTEM



OPTICAL-HAPTIC SUBSTITUTION

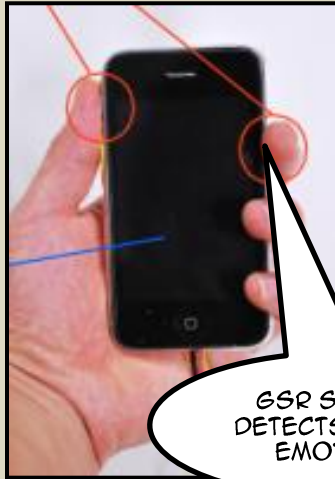
"SENSEABLERAYS: OPTO-HAPTIC SUBSTITUTION FOR  
TOUCH-ENHANCED INTERACTIVE SPACES"  
J. REKIMOTO

BACKGROUND:

MOBILE DEVICE  
INTERFACES

## AFFECTPHONE

DETECTS A USER'S EMOTIONAL STATE USING GSR, AND CONVEYS THIS STATE VIA CHANGES IN THE TEMPERATURE OF THE BACK PANEL OF THE OTHER HANDSET



GSR SENSOR  
DETECTS USER'S  
EMOTIONS

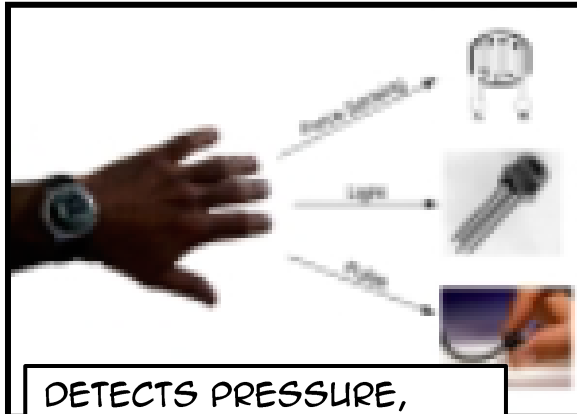
PELTIER DELIVERS  
WARMTH OR  
COOLNES



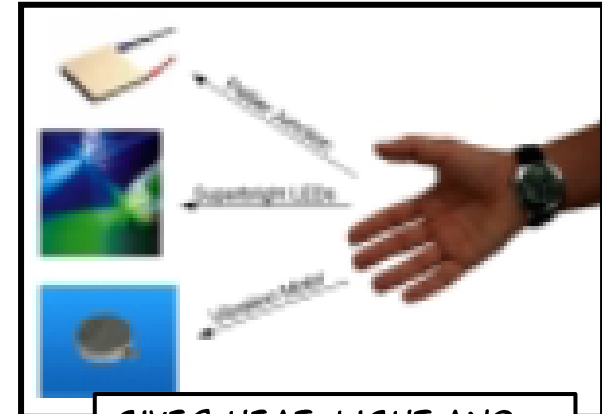
"AFFECTPHONE: A HANDSET DEVICE TO PRESENT USER'S EMOTIONAL STATE WITH WARMTH/COOLNESS"  
K. IWASAKI, T. MIYAKI, AND J. REKIMOTO

## CONNEXUS

AIMS TO DETECT VARIOUS CONDITIONS AT A TIME AND TRANSMIT THEM IN DIFFERENT WAYS



DETECTS PRESSURE,  
AMBIENT LIGHT AND  
HEARTBEAT



GIVES HEAT, LIGHT AND  
VIBRATION

"CONNEXUS: A COMMUNAL INTERFACE"  
E. PAULO

BACKGROUND:

SENSORY  
SUBSTITUTION



## BRAINPORT AND EYEBORG

IMAGES CAPTURED BY  
THE CAMERA...



... ARE TRANSLATED TO  
ELECTRICAL SIGNALS IN THE  
TONGUE



"BRAINPORT: AN ALTERNATIVE INPUT TO THE BRAIN"  
Y. DANILOV AND M. TYLER

USES A COLOR SENSOR  
AND CAMERA TO  
TRANSLATE...

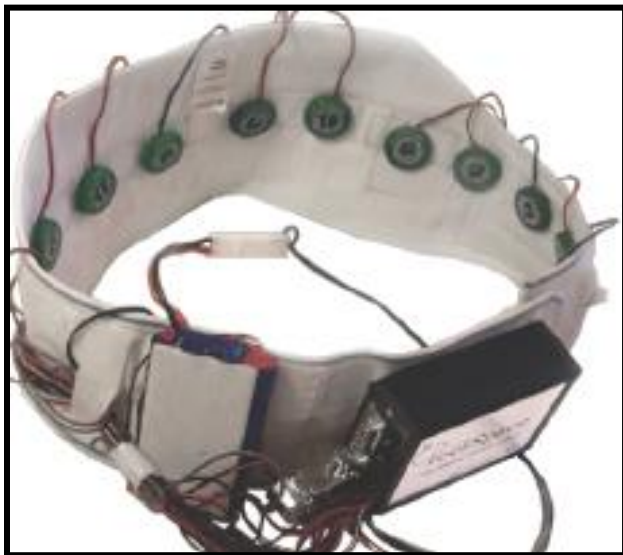
... COLOR INFORMATION  
TO SOUND



"EYEBORG"  
NEIL HARBISSEON

BACKGROUND:

NEW SENSES

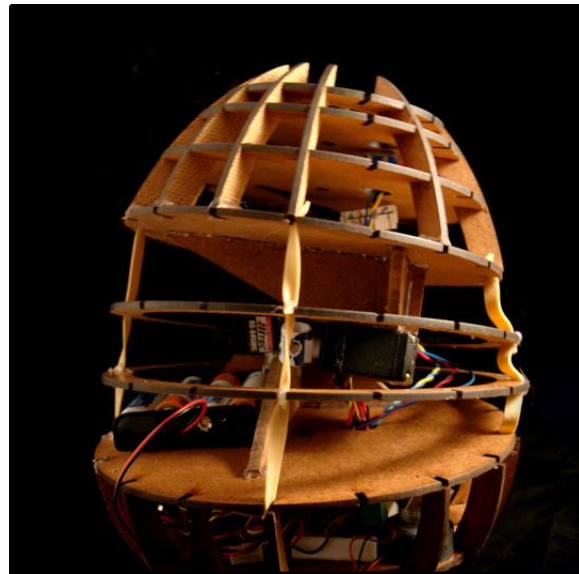


"FEELSPACE BELT"  
NAGEL, S. K., CARL, C., KRINGE, T., MÄRTIN, R.,  
& KÖNIG, P.



"BODY HACKING: MY MAGNETIC IMPLANT"  
D. BERG

FEELSPACE BELT,  
BODY HACKING AND  
MOMO



"MOMO: A HAPTIC NAVIGATION DEVICE"  
C. WANG AND K. O'FRIEL



# SITUATIONAL AWARENESS

TAKE INFORMATION FROM THE ENVIRONMENT, INTEGRATE IT WITH PREVIOUS KNOWLEDGE AND FORM A COHERENT MENTAL PICTURE





# NEUROPLASTICITY

THE ABILITY OF THE BRAIN TO  
ASSIMILATE NEW INPUT

# DIGITAL SYNESTHESIA

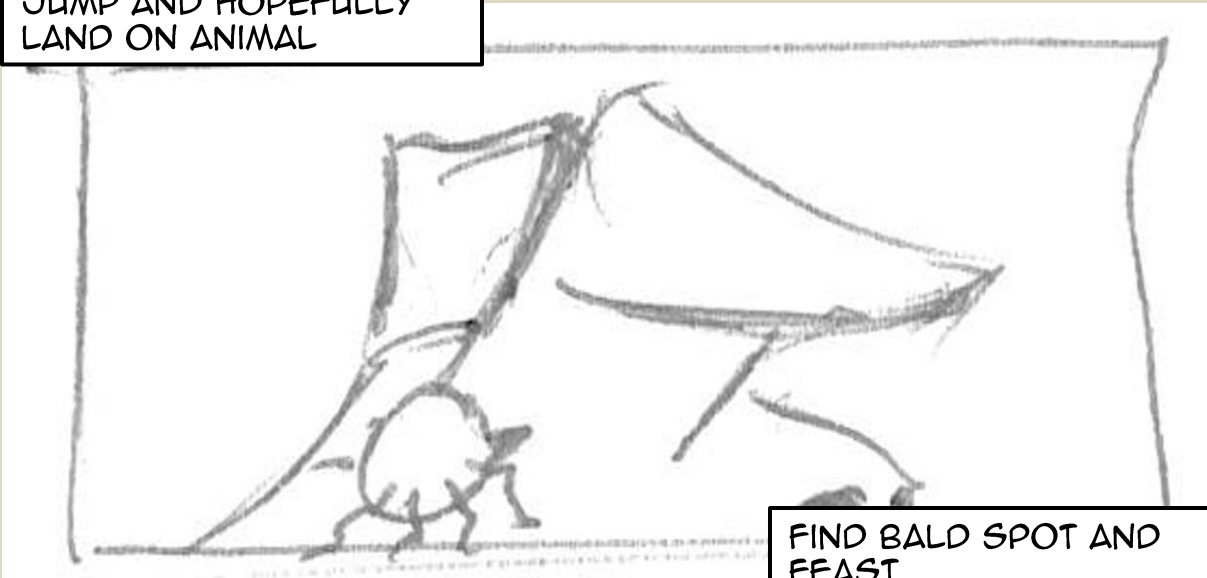
SKIN'S LIGHT SENSITIVITY  
TO FIND A TALL GRASS



SENSE VICTIM THROUGH  
SMELL



JUMP AND HOPEFULLY  
LAND ON ANIMAL



FIND BALD SPOT AND  
FEAST

THE TICK UNDERSTANDS  
ONLY THREE SIGNS

SMELL

TEMPERATURE

HAIRINESS

"A FORAY INTO THE WORLDS OF  
ANIMALS AND HUMANS"  
JAKOB VON HEXKÜLL

BEEES CAN USE UV LIGHT  
TO PICK FLOWERS



HAMMER-HEAD SHARKS  
HUNT SENSING ELECTRIC  
SIGNALS FROM THE  
MUSCLES OF PREY





## COGNITIVE LOAD

WHEN BY-PASSING THE VISUAL SENSE, IT IS EASIER FOR THE BRAIN TO INTERPRET INFORMATION WITHOUT SHIFTING ATTENTION FROM CURRENT TASK



# Digital Synesthesia

- Personal interpretation

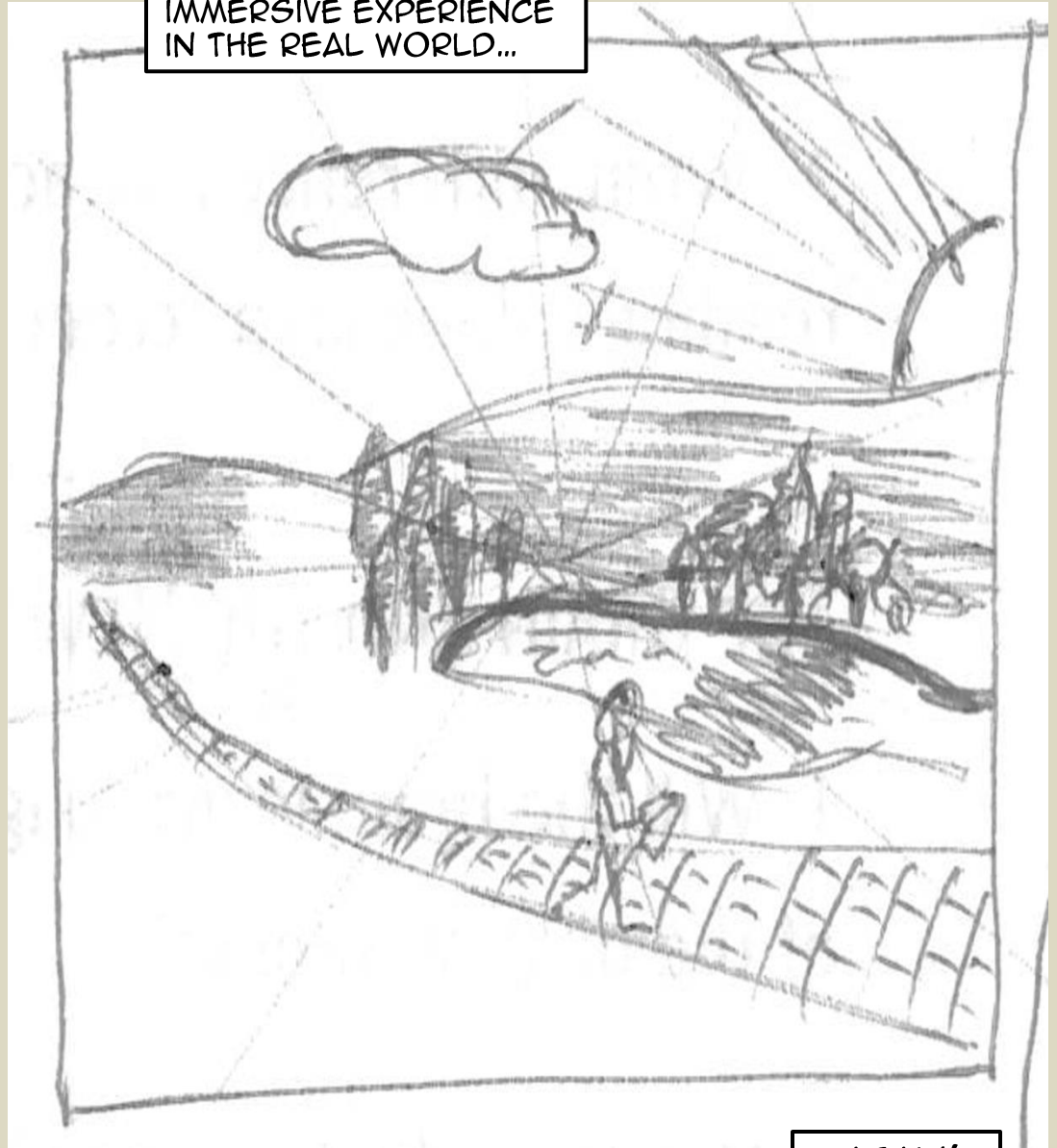
MOBILE DEVICES OFFER  
CONNECTION...



... AND ALSO  
DISTRACTION

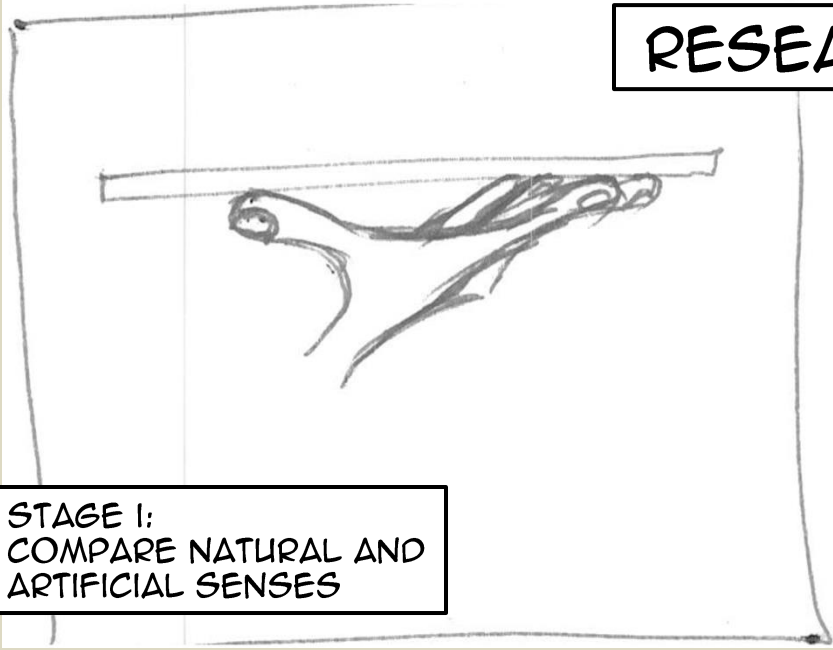


DIGITAL SYNESTHESIA  
WILL CREATE AN  
IMMERSIVE EXPERIENCE  
IN THE REAL WORLD...



... AGAIN!

# RESEARCH PLAN



STAGE I:  
COMPARE NATURAL AND  
ARTIFICIAL SENSES

STAGE II:  
NEW SENSES IN A  
KNOWN CONTEXT

STAGE III:  
NEW SENSES WITH  
UNKNOWN CONTEXT

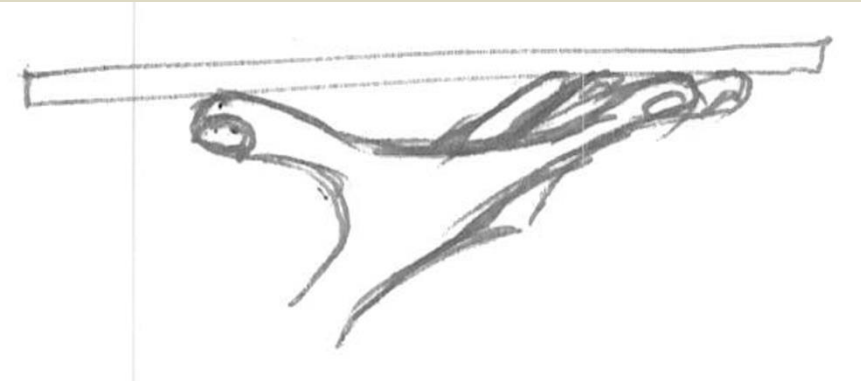
STAGE IV:  
GENERALIZING  
PROJECTIONS OF  
SYNESTHETIC DESIGN

# RESEARCH PLAN, STAGE I

A GLOVE WITH A  
PRESSURE  
SENSOR...

... ON THE TIP OF  
THE RING FINGER

THE USER WILL  
HOLD A TRAY AND  
LOCATE VARIOUS  
OBJECTS ON IT



THE TASK IS TO  
ORGANIZE THE  
OBJECTS ACCORDING  
TO WEIGHT



# RESEARCH QUESTIONS, STAGE I

DISCREET OR CONTINUOUS?

DOES THE USER FIND DISCREET SIGNALS BETTER THAN A CONTINUOUS CHANGING SIGNAL?  
DOES THIS DEPEND ON THE EXPERIENCE?

SENSE AUGMENTATION?

IS THERE A BENEFIT OF THE ARTIFICIAL SENSE OVER THE NATURAL SENSE WHEN USED TOGETHER?

SENSE SUBSTITUTION?

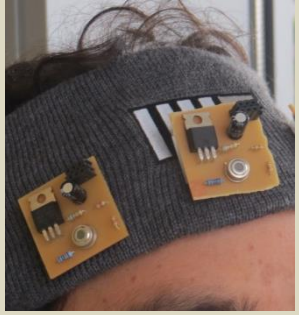
CAN THIS ARTIFICIAL SENSE REPLACE AN EXISTING SENSE FOR THE GIVEN ACTIVITY?

NEW STIMULI?

HOW ACCURATE IS THE DIGITAL SENSE IN COMPARISON TO THE NATURAL SENSE?

# RESEARCH PLAN, STAGE II

HEAD BAND



OUTWARD IR SENSORS ON THE FOREHEAD

INWARD TRANSDUCERS

SET UP A GROUP ACTIVITY



USER WILL HAVE AN ADVANTAGE



DETECTING THE STRESS LEVEL OF THE OTHERS



## RESEARCH QUESTIONS, STAGE II

### NEW SENSES?

HOW DOES THE USER PERFORM WHEN HAVING ACCESS TO A NEW SENSE?

### NEW STIMULI?

HOW ACCURATE IS THE DIGITAL SENSE IN THE CONTEXT?

### SENSE SUBSTITUTION?

CAN THIS ARTIFICIAL SENSE REPLACE AN EXISTING SENSE FOR THE GIVEN ACTIVITY?

IS THERE A PHANTOM SENSE FEELING?

IS THERE A DIFFERENCE DEPENDING ON THE USER'S FAMILIARITY WITH THE TASK?

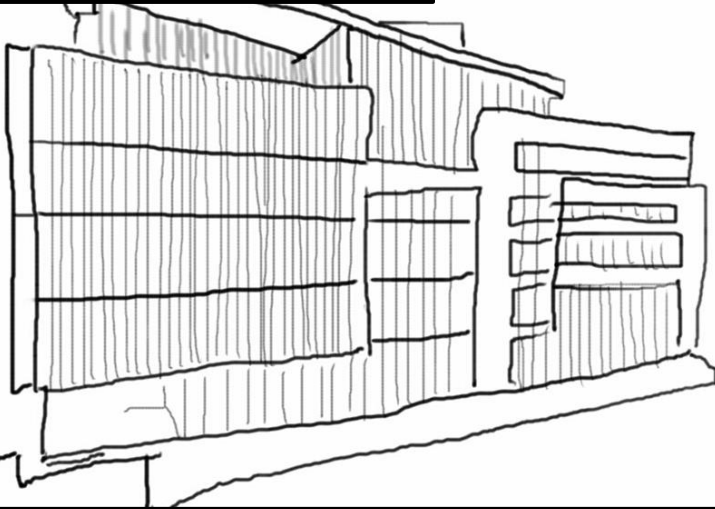
# RESEARCH PLAN, STAGE III

NECK

PELTIER DEVICE RESPONDS TO LOCATION...

WITH THE GLASS INFRASTRUCTURE

INTERACT WITH THE LAB



USE DOPPELLAB  
TO INTERACT WITH  
THE USER

# RESEARCH QUESTIONS, STAGE III

HUMAN DEVELOPMENT?

WHEN LEARNING A NEW SENSE, ARE CHILDREN BETTER AT IT THAN ADULTS?

NEW STIMULI?

HOW FAST TO USERS UNDERSTAND THE NEW STIMULI?

DOES IT DEPEND ON THE ACTIVITY OR THE FEEDBACK?



# RESEARCH PLAN, STAGE IV

DESIGN  
THINKING

... TREE

FROM  
SAPLING...

# RESEARCH QUESTIONS, STAGE IV

ESCAPING THE VISUAL INTERFACE?

CAN THIS ARTIFICIAL SENSE REPLACE AN EXISTING SENSE FOR THE GIVEN ACTIVITY?

DESIGN THINKING?

CAN A PATTERN BE IDENTIFIED TO GENERALIZE A DIGITAL SYNESTHESIA DESIGN PROCESS?

# Timeline

THE END

THANK YOU...

QUESTIONS?