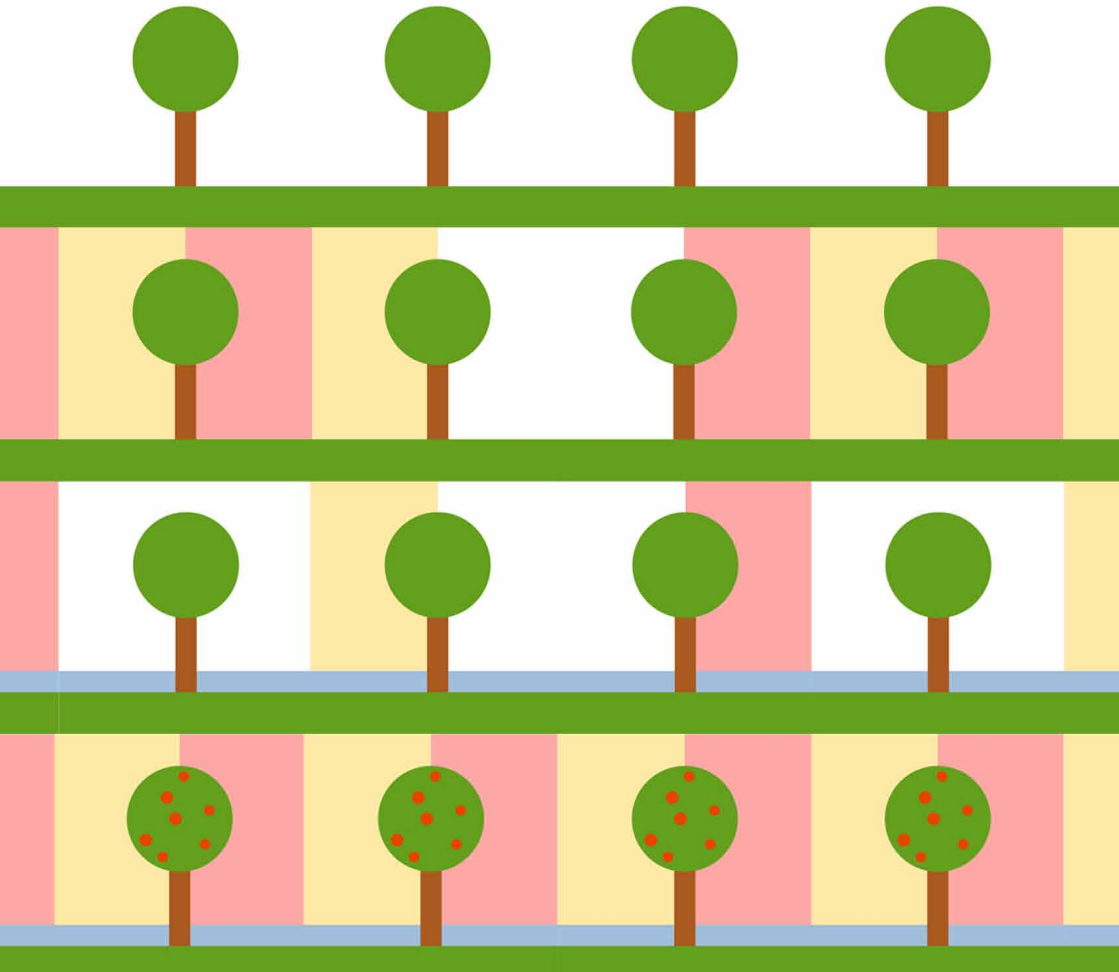
DESIGN RESEARCH DOCUMENT

Moritz von Burkersroda



Design Research Document

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Research Proposal

I plan to research into interactive installations, which can be useful for learning - ideally by explaing an abstract content. Therefore I want to look into methods, that enable interactivity – technically and visually. Analysing examples for their technical background, visual language and their potential for learning. Furthermore I want to imitate those elements, which have a potential to be used for my Final Major Project. For that I am aiming to explain an abstract conent - more precise, the process of photosynthesis.

Areas of Design

- interaction design
- information design
- data visualisation

Context

- interaction design
- physical computing
- museum education
- biology
- visualisation of abstract content

Process of Interaction

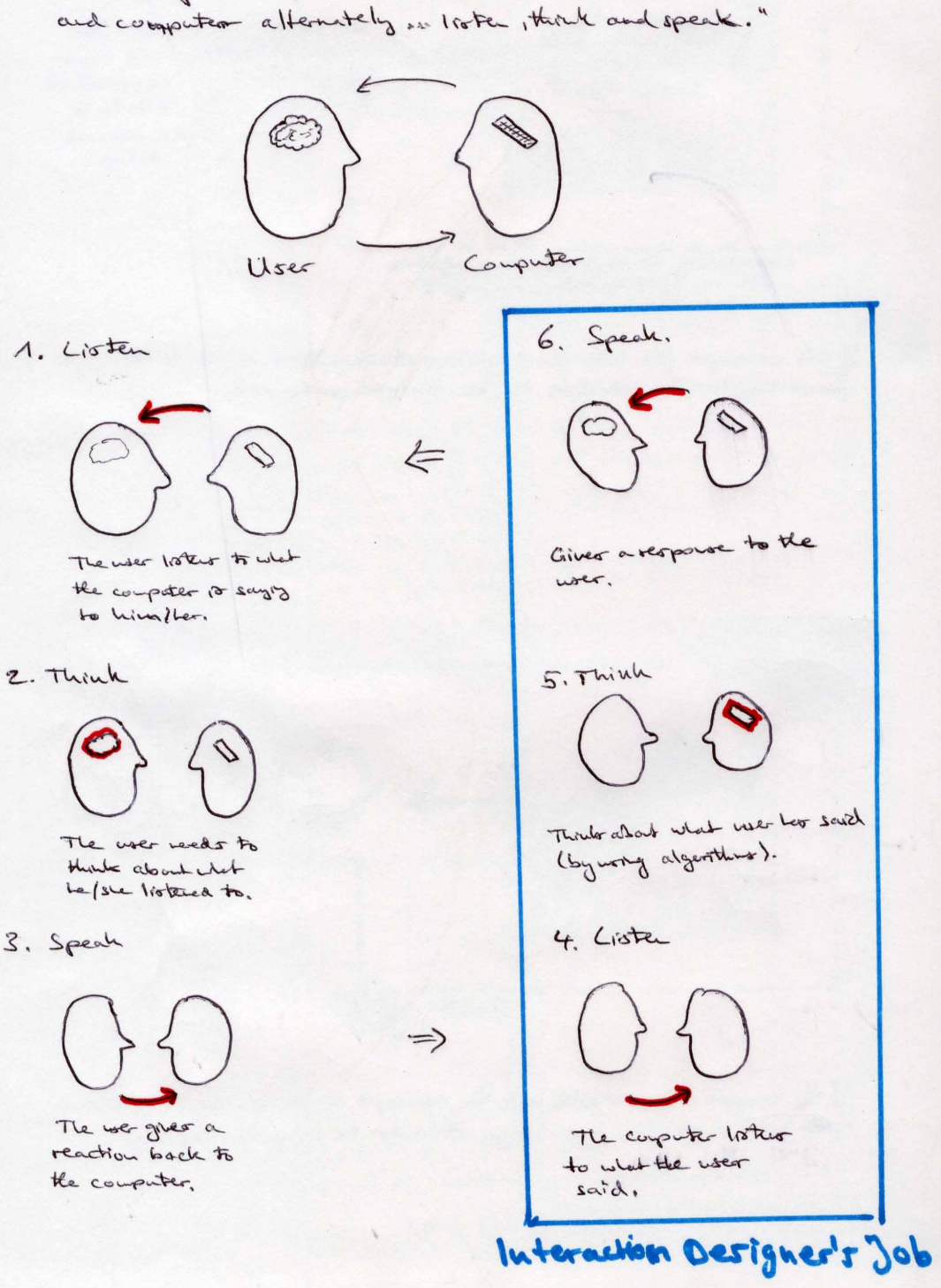
Model by Chris Crawford

"Interactivity is a cyclic process in which the user and computer alternately..listen, think and speak."

(Chris Crawford)

Chris Crawford is an interactive designer and published many books in the area. 'The Art of Interactive Design' explains his model of the 'Process of Interaction'. A simplified visualisation of the model he presented in a lecture for Software designers (redrawn image on the right).

The interaction designer's job is to enable all three steps the computer has to do of 'listening' and 'speaking' to the user, as well as 'thinking'. If one these has note been done right, the 'conversation', as he descibes the process, isn't possible. Clear understanding of what the user wants, and clear articulation, which the user understands is key. And the translation between the two needs to be done by a way of 'thinking', which is only helpful for the user, if it differs from his/her way of thinking.



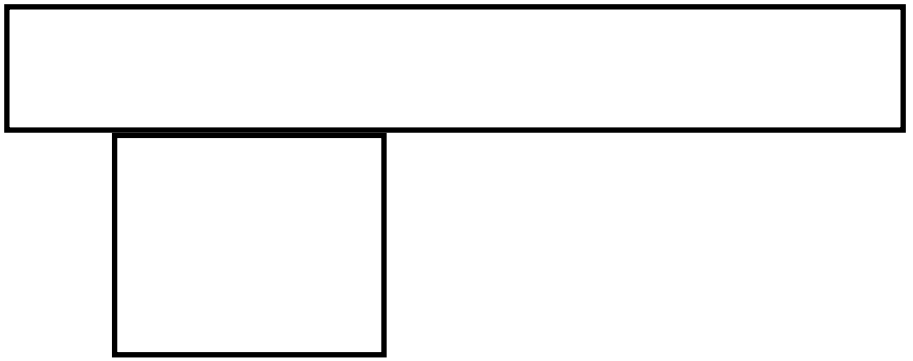
Constructivist Learning Theory

Based on Jean Piaget

"According to Piaget, Learning is in essence identical to acquiring a permanent qualitative change in the cognitive structure. Learning causes exisitng structures to become differenciated and coordinated."

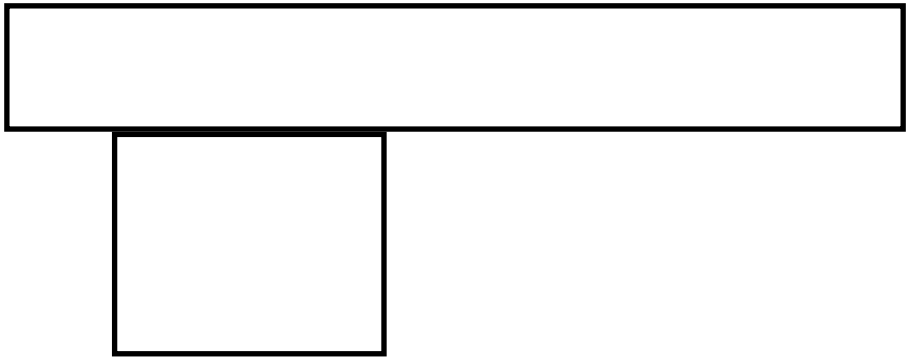
(Joseph Zajda)

Constructivist learning theory is based on the theory, that learning takes place without external stimuli. Jean Piaget is one of the pioneers in this area.
Joseph Zajda took this concept in his book 'Learning and Teaching' and connected it bit by bit to the practice. To help me understand how it works I tried to structure the description. Afterwards I decided, as part of my visual reserach, to visualise this abstract content, restructure it and enable interactivity to a certain extend, to make it easier to understand. Also I added, when this concept becomes relevant for designing educational content.

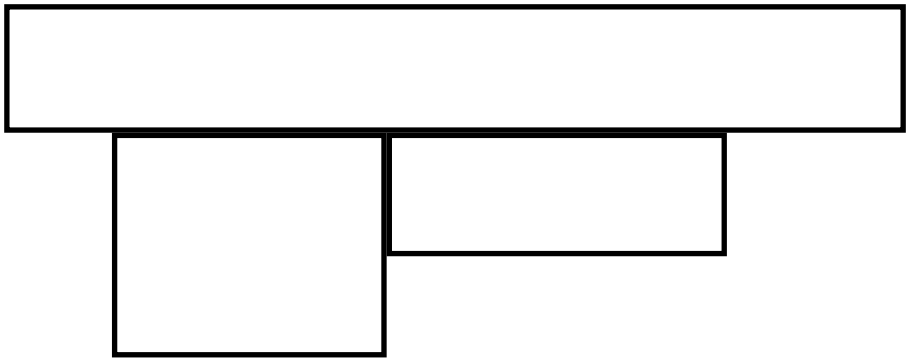


If the learner doesn't reflect on the experience, the knowledge will stay object bound. That means, if the learner leaves the installation now, he/she won't have learned anything, which he/she could apply outside the installation.

Designer's job: Make interaction clear to user; give options to play around (by interactivity); confront learner with a new experience.

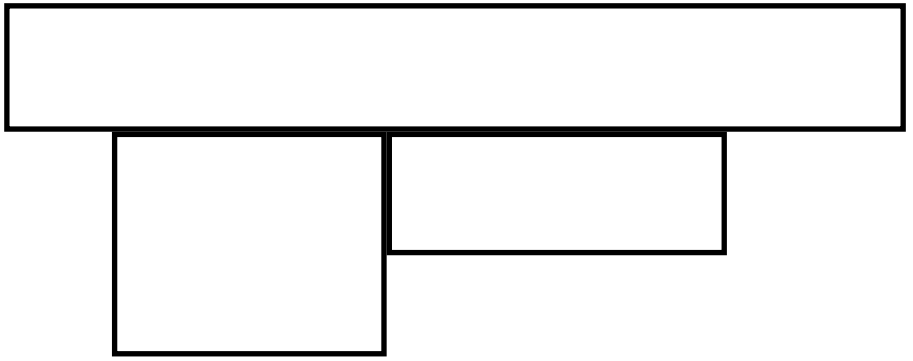


Example:
'If I push THIS button, THIS lamp will flash up.'

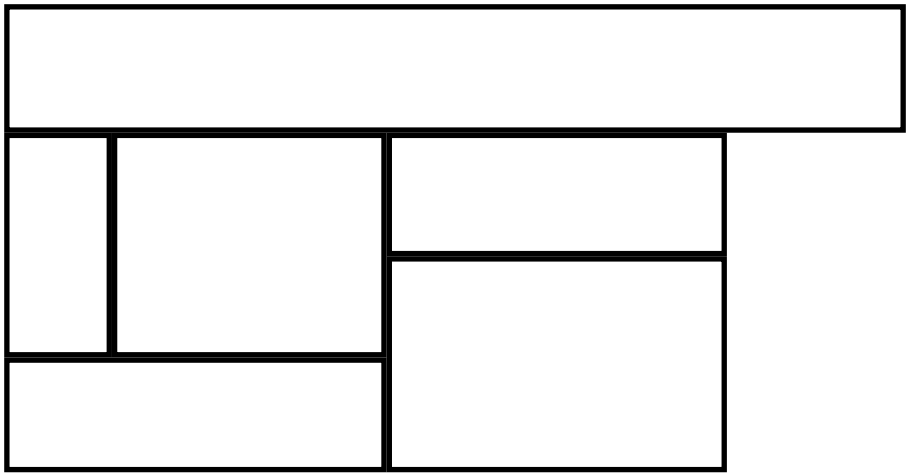


If the learner constructs a concept by reflecting on his/her action, which would explain the experience, this might lead to learning.

Designer's job: Suggest a concept or give enough information to build one themselves.

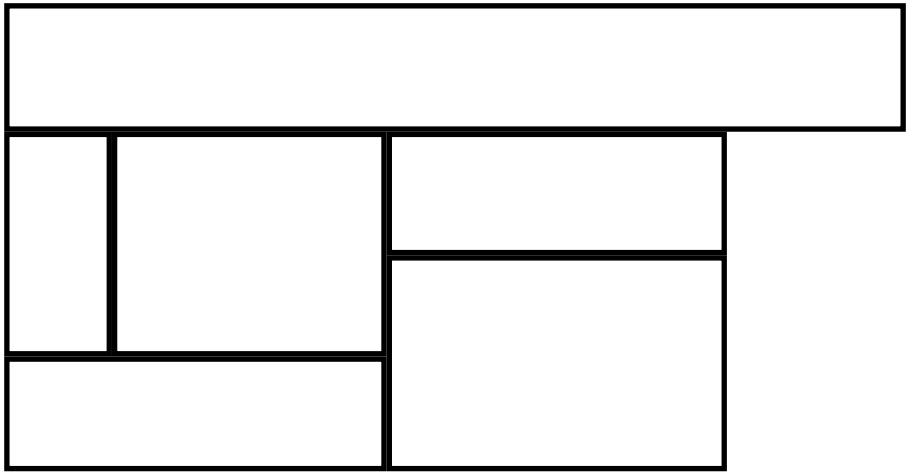


Example:
If a button gets pressed and is connected to a light in a circuit, the button closes the circuit allowing electricity to run through the lightbulb, which will light up.'

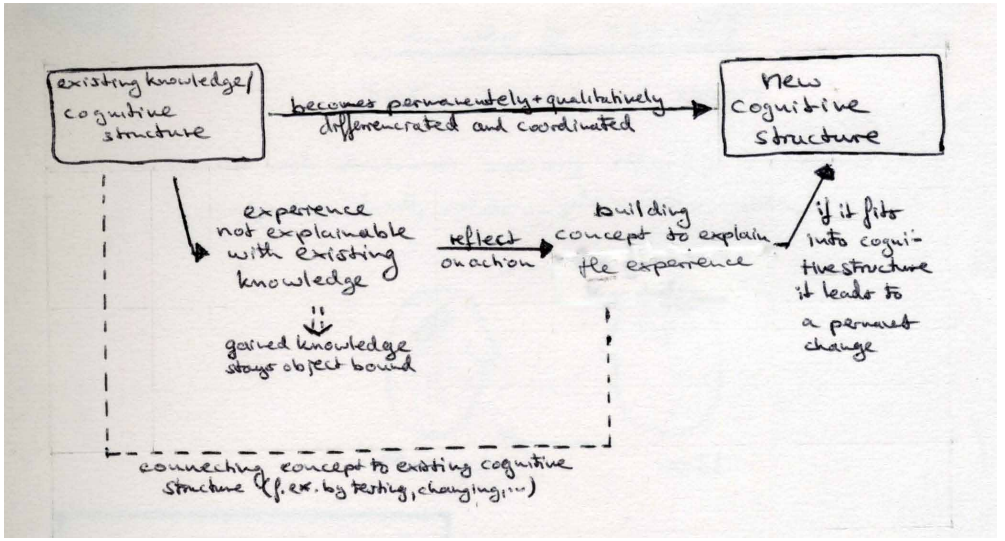


By testing and possibly changing the concept connecting it to existing knowledge and the gained experience, will eventually lead to learning. If the connection can't be made learning won't take place, because of a lack of needed knowldege to fill the gap.

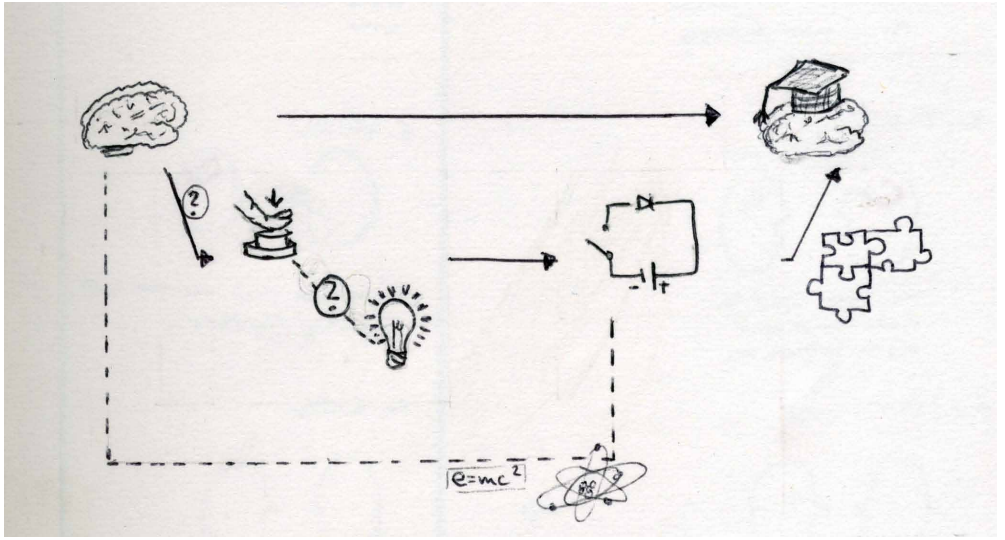
Designer's job: Give aids to help the user identifly oneself with the content (for example by giving structure, using visual metaphors). Pick up learner, where he/she is.



Example:
'This concept makes sense, because it relates to phyisics, which I know.'
... or ...
'This doesn't make sense.'



If the concept fits into the cognitive structure, it leads to the previous knowledge to be changed, as it adapts the new concept.

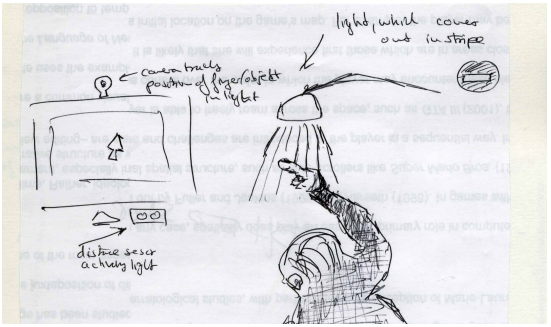


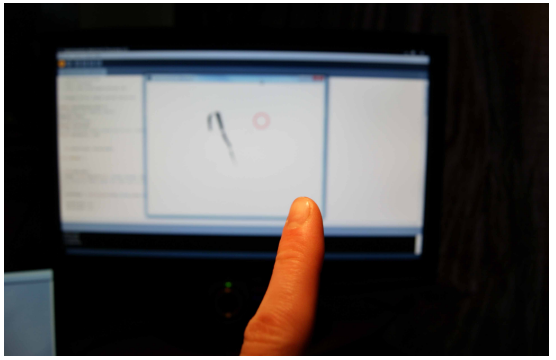
Example:
'This concept makes sense, because it relates to physics, which I know, and it makes sense.'

Finger to Mouse (+Voice Control)

Camera Input & Processing (+STT Library)

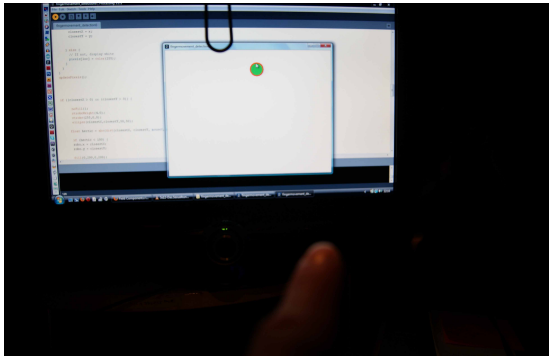
The idea was to be able to control the mouse-movement on your computer by using the movement of your finger.



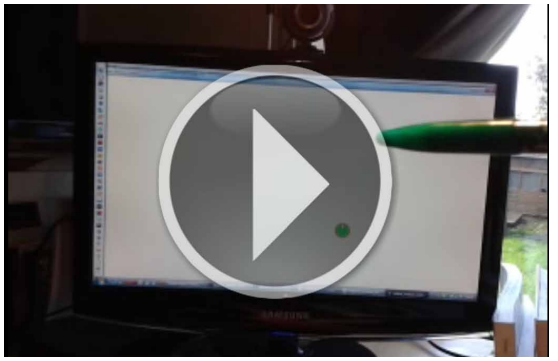


With a code (from Jason) that detects motion from your webcam, I was a bit closer to my aim. Unfortunately, it would detect motion from everything that it sees and moves, so not just my finger, but also my body, because the code compared the change of the colour of pixels and detected those as mvement. Therefore I decided to darken up the room and only allow a 'strip' of light to come through to light up my finger. I did that by installing something on the lamp I constructed.

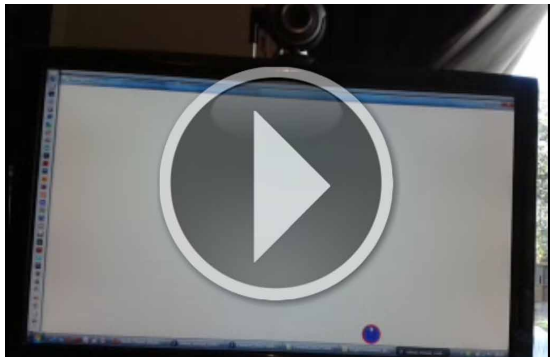
The Processing code mirrored the image, but i corrected that and made a red circle move around simulaneosly to the finger in the light.



To actually then move the mouse in Windows, I used the so called 'Robo-class' for Processing by irag (http://wiki.processing.org/w/Robot_class). Every time there was motion detected 'close to the mouse', the circle filled with green and the position of the circle controlled the position of the mouse.



Even though it worked, it only worked to a certain extend. So I decided to use the a colour detection code for Processing, instead of the motion detection. This would have a significant change: no darkening up of the room, but instead using a 'unique' coloured object to navigate the mouse smoothly. It worked great!



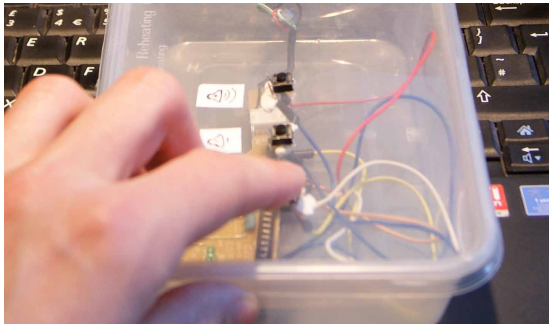
I then decided to add a new component into it: audio-control. The Processing-Library STT uses Google Chrome's free dictation feature. Therefore it can convert audio into written words by checking a huge database online. Adding it to my sketch, the colur of the circle could be changed by audio-commands.

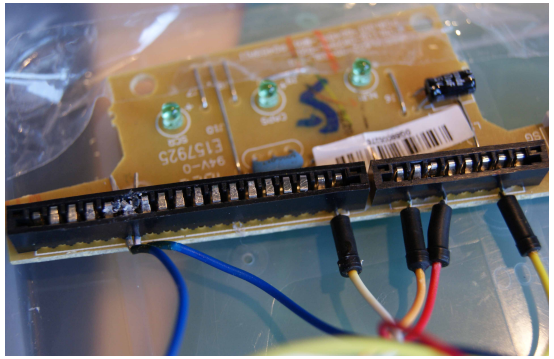
TECHNICAL RESEARCH

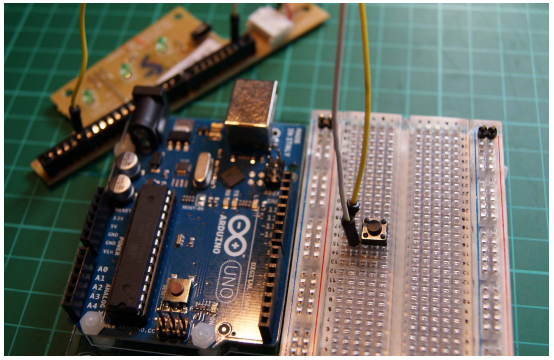
Keyboard Hack

Old Keyboard & Push Buttons

Many buttons on the keyboard are unnecessary for everyday use. This is a way of making your own keyboard.







In every keyboard you can find a chip with several pins. Usually the pins are connected through plastic sheets with conducted coating on it. The keys close the circuit in between and give a signal to the chip.

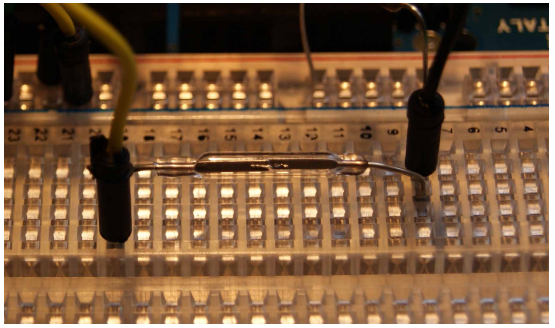
By just connecting two pins with a cable and opening your text editor, you can find out, which keystroke the connection enables. Placing a bushbutton in between will close the cicuit on demand.

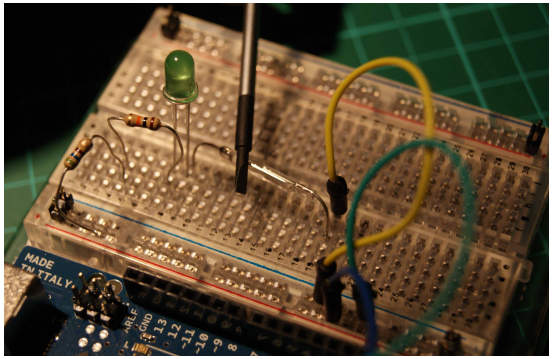
This opened up the opportunity to add more buttons and set these buttons up as ‘hotkeys’ in the VLC media player. ‘UP’, ‘DOWN’ and ‘SPACE’ button, can now be used as ‘Volume up’, ‘Volume down’ and ‘Pause/Play’.

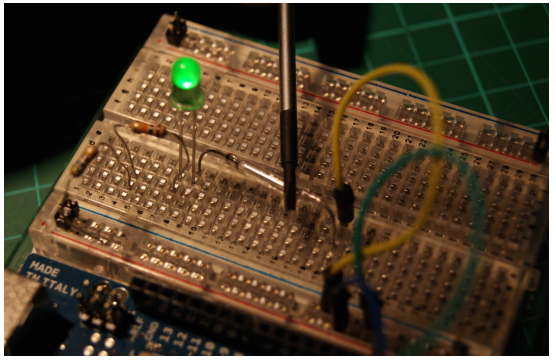
Reed Switch

Aduino, Reed Switch and Magnet

Turning off and on a lamp, without even touching it.







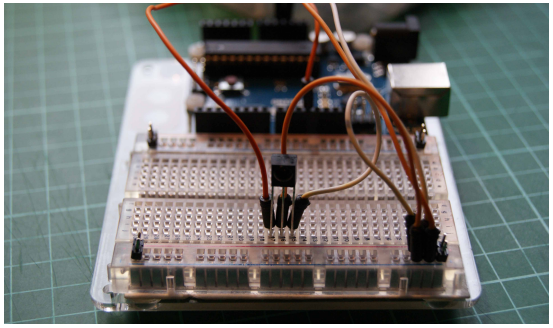
Instead of a push-buttons to close a circuit, it is also possible to use reed switches. Instead of pushing, they react to a magnetic impulse.
Depending on the strength of the magnet, this could be very impressive, as no physical contact is necessary to activate the switch.

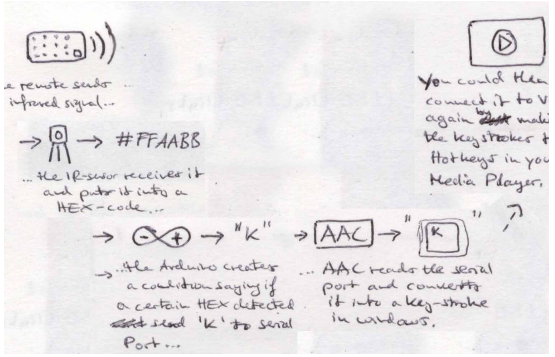
Taking a small magnet (like here on the top of a screwdriver), can demonstrate the exact place on the reedswitch, where a magnetic impulse closes the circuit and lights up the LED-light.

Remote Control

Ardino, Infrared Sensor & Remote

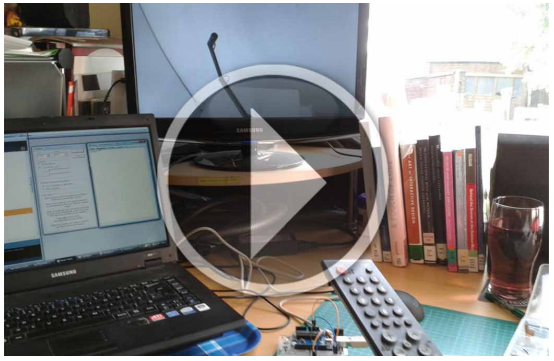
Wireless control with more options by using your TV remote.





The IR-sensor receives signals form everything that sends out IR-signals. These can be read by the Arudino , which displays the HEX-code of them.

The kit came with a remote, but I found out that my TV-remote works much better with it.

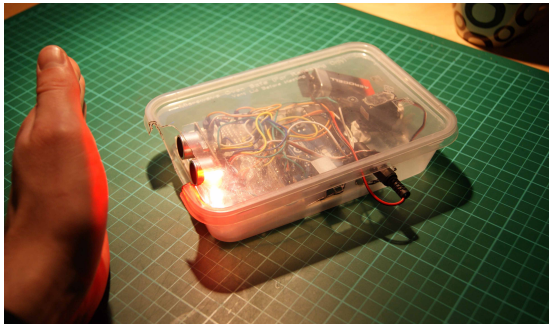


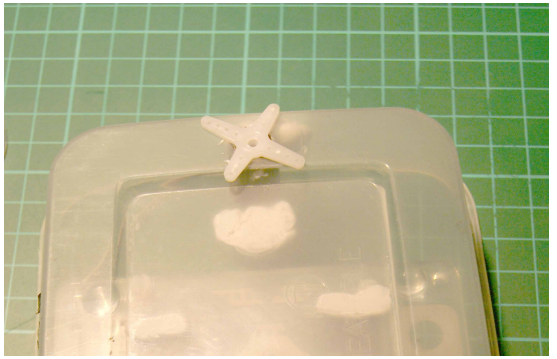
To use the TV-remote like a keyboard on the computer I found the program AAC-keys, which converts singals received by a chosen Serial Port into a keystroke. All I needed to do then was to send an appropriate Signal to a Serial Port using my Arduino.

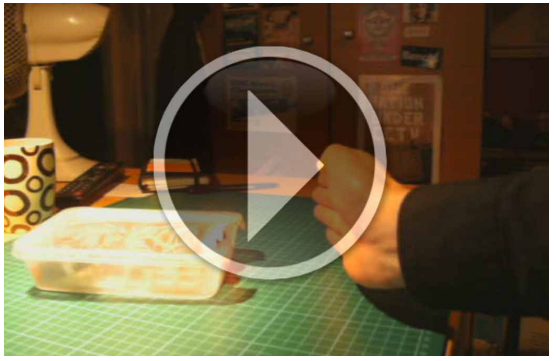
The Claustrophobic Lunchbox

Ardunio, Distance Sensor & Servo Motor

In this experiment I wanted to explore output methods for the Arduino. How about a robot that panics if you get too close?







I used the values of a distance sensor to manipulate the movement of a servor-motor attached to the bottom of a lunchbox, which makes it move slightly.

If there is an object detected within a set distance, the LED flashes up. The closer the object is, the more hectic the movement of the servo-motor becomes (actually the time between reading through loops becomes shorter).

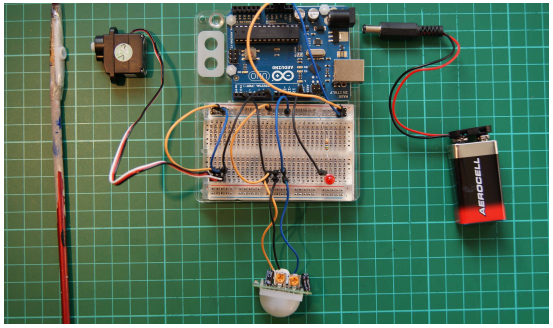
If there is no object detected within reach, the movement is less hectic and only occurs from time to time.

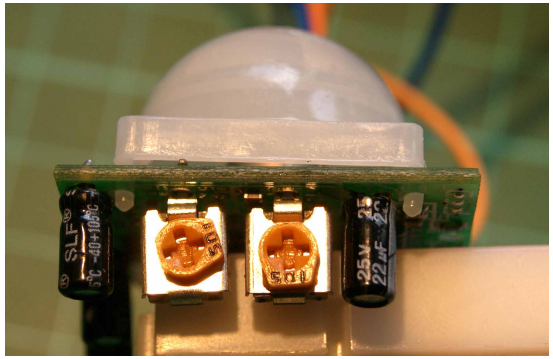
TECHNICAL RESEARCH

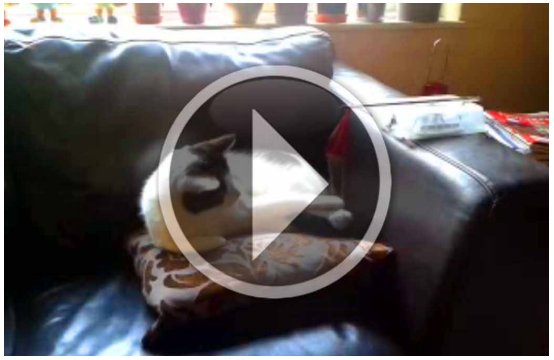
Cat Toy

Ardino, PIR Motion Sensor, Servomotor & a Cat

*In the left corner with a weight of 400g the 'Centrfigugic Silver Foil Swinger' ... aaaaaand in the right corner the 'Furry Scratch Attack" ... *ding*ding*ding**







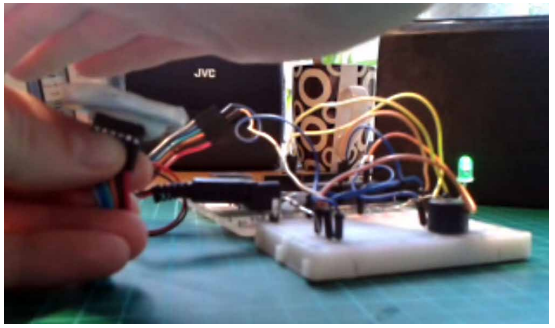
PIR stands for (Pyrotechnic InfraRed Sensor) and as the name reveals it detects InfraRed light, something every object emits. The PIR therefore doesn't directly detect movement, but detects if IR values in its environments are changing, therefore moving. The two variable RT resistors have influence on the delaytime a new signal gets sent (unfortunately not under one second), the other controls distance senability.

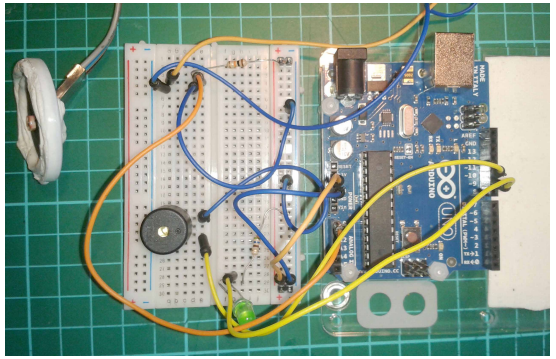
For the 'Cat Toy' I let the servomotor randomly moves, everytime the PIR sends a signal. The motor was extended by a brush with an elastic band and kitchen foil on it. The cat acted not impressed, but still seemed curious.

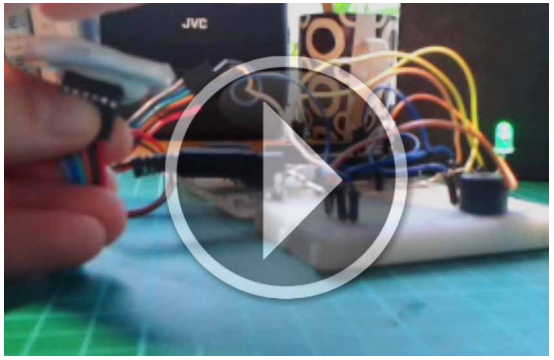
Hearing Light

Ardunio, Photoresistor & Piezo Element (Speaker)

This musical instrument you can play without even touching it.







Photoresistors produce a resistance, which variable depends on the amount of incident light. Here, I use these values and applied them onto the Piezo.

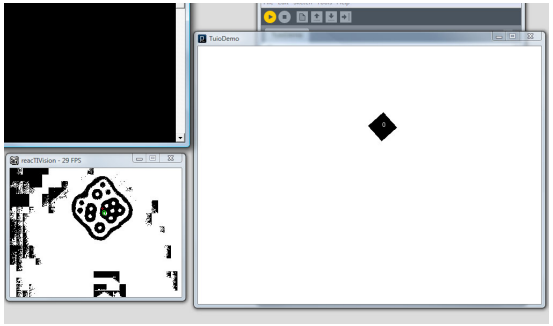
Piezo Element is a motor, which contains a disc. By applying directional force to an axle it causes the disc to rotate. The pusle of current causes a click; a stream of pulses will cause to emit a tone. Therefore you can imitate notes of a musical scale.

Because of differing light-intensity in environments, I programmed a calibration within the first 7 seconds - detecting the lightest and darkest state.
The less light, the lower the tone in the musical scale. The lightest state, won't produce any tones.

Interactive Table

Webcam, ReacTIVision & Processing

I've been wondering, how that installation 'Noteput' worked... but now I could do it myself.



"ReacTIVision is an open-source, cross-platforming computer vision framework fro the fast and robust tracking of fiducial markers attached onto physical objects as well as multi-touch finger tracking. It is a standalone application, which sends TUIO messages via UDP prot 3333 to any TUIO enabled client", like for example Processing - that is if the library is installed and the Firewall allows UDP communication.
The fiducial markers can be found in a PDF-file and when printed, read by any webcam. Example Sketches can be found in the library folder.

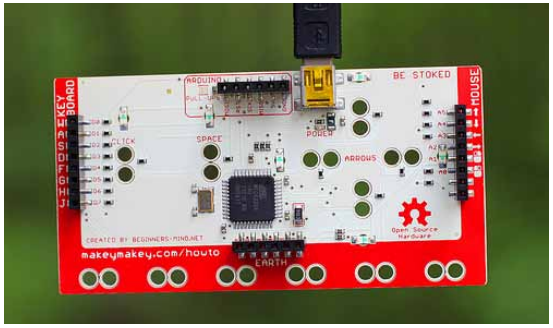
My prototype table out of LEDs, mirror & webcam, served to test ReacTIVision for its potential.

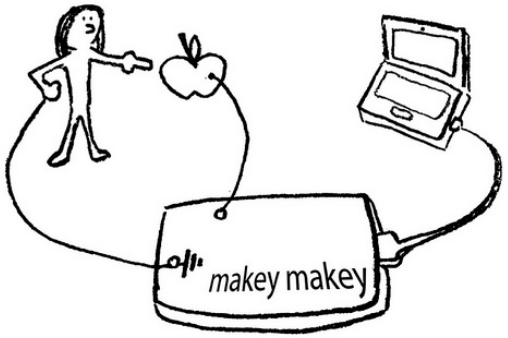
MaKey MaKey

by Jay Silver & Eric Rosenbaum

"Make + Key = MaKey MaKey"

(www.makeymakey.com)





MaKey MaKey is an invention by MIT Media Lab graduates Jay Silver and Eric Rosenbaum. It enables everything, that is at least a tiny bit conductable to turn into a key for your computer. It can detect if a circuit between an object and another object - both connected to the MaKey MaKey using alligator clips - is closed or not.

This enables to use objects as an input device, that serve as a much more natural interface than the keyboard.

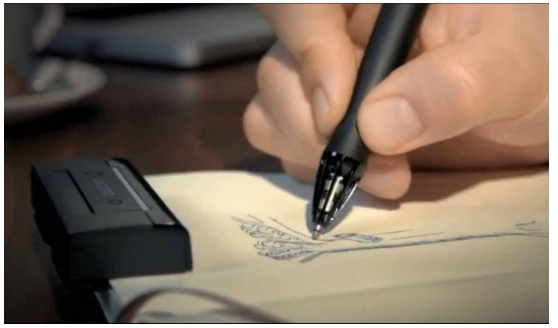
MaKey MaKey has some extra just for the Arduino - is therefore importable into Processing.

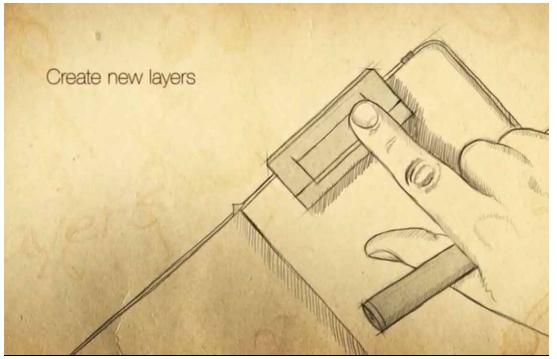
Inkling

by Wacom

"Inkling enables you to start off your artwork the traditional way, while making the first step of your digital workflow simultaneously – wherever you are."

(www.wacom.eu)





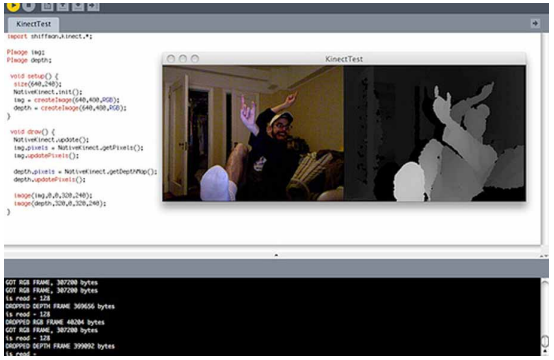
The Inkling consists of a wireless receiver and a pressure sensitive pen, which reads up to 1024 levels of pressure. The pen emits inaudible pulses of sound (like bats emit sonar sound), which gets picked up by two microphones on the base unit. This detects the location of the pen and converts it to vectors. By pressing the base unit, a new layer gets created.
Apparently the accuracy of the drawings recognised by the Inkling are not seemless. A review by Richard Stelmach shows the difference of the scanned in image, and the image made by the Inkling (look left). Nevertheless, the technology might be useful for inputs, that don't need to be as precise.

Kinect

for Xbox

“You are the controller”

(www.xbox.com)



The Kinect was first introduced for the Xbox as an alternative controller input. It consists of three subsystems. The optical system contains depth projector, which projects IR light, a depth sensor, which detects IR light reflected, and an RGB camera.
The 3D model shows this: surfaces reflecting the light get detected. The RGB cam simply projects the image onto the model.
The detection of body parts functions through a huge database of pre-determined gestures. Therefore Kinect detects our gestural moves and converts them into a control-input.

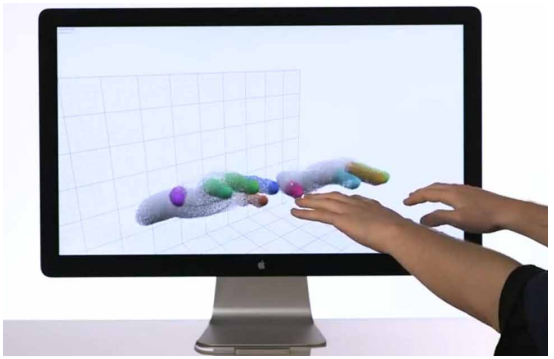
It’s even possible to use the Kinect with Processing by installing Daniel Shiffman’s ‘openkinect’ library.

The Leap

by Leap Motion

“Say goodbye to your mouse and keyboard.”

(www.leapmotion.com)



The leap advertises itself to be more accurate than a mouse, and more sensitive than a touchscreen. In essence it works similar to the Kinect but more precise (“200x more accurate than anything else on the market”). This 3D representation shows again, how the Leap can detect its environment.

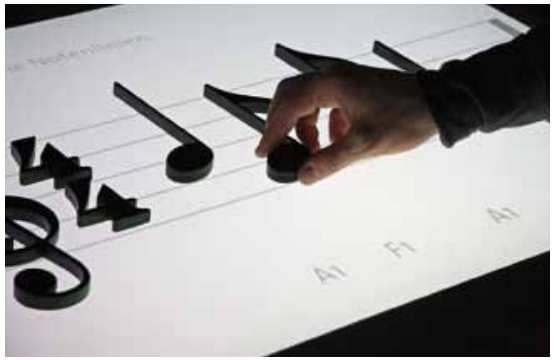
Unfortunately, it’s not yet possible to gather more informaton about it yet, as it’s gonna be available on the market beginning of 2013.

Noteput

by Jonas Friedemann Heuer & Juergen Graeff

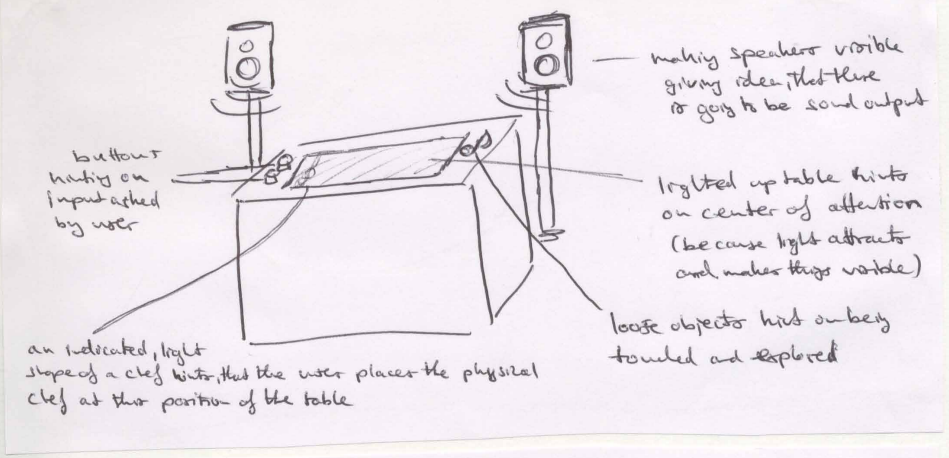
"Noteput is an interactive music table with tangible notes, that combine all three senses of hearing, sight and touch to make learning a classical notification of music for children and pupils more easy and interesting."

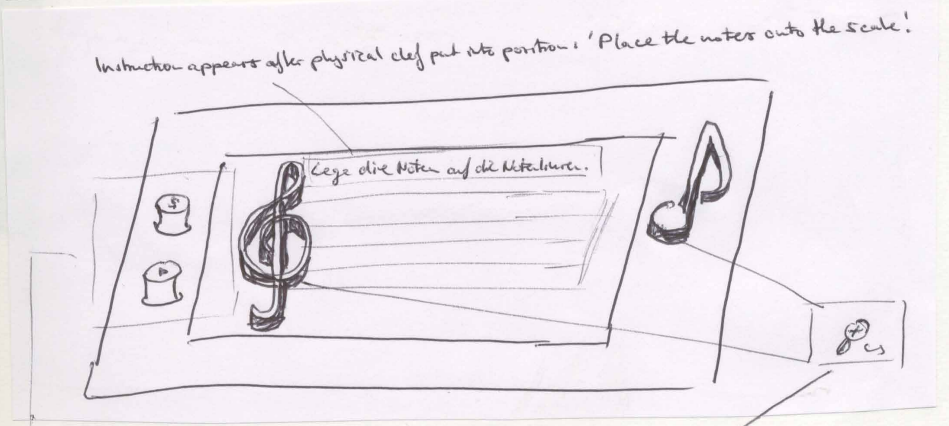
(www. jonasheuer.de)



Physical feedback is enabled through the wooden, tangible notes, which are differently weighted, depending on their note value. Shape of the note reassures the difference between notevalues.
Is a note placed on of the table (appearing after placing the physical clef on the highlighted spot), the installation gives an immediate auditive (through speakers) and visual feedback (through written noten-name on the table).

By hitting the play or repeat button, the sequence of the notes played is visually supported by a vertical stroke going along from left to right, as well as the note-name's typesize enlarging, as the notes gets played.





The 3-D physical objects could be associated with the visual representational language of music, for everyone who has seen those before.
By placing the clef on the lighted up table, staves will appear, which are another reassurance, that the objects are used as representational elements of the musical language. → +shapes
By giving the note values different weighting, the user can associate, that there is a difference in between notes - what difference that is, the user has to experience - if they don't already know.

'Loop' button: arrows in their circulating shape could also hint on the recycling symbol, but might be associated with 'repeat' and/or option, since notes and speakers hint on audio-output/input

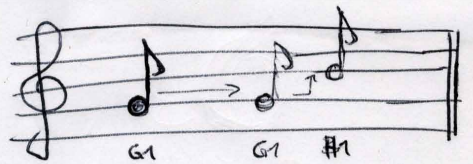
'Play' button: familiar symbol that hints on a sequence being played

The tabletop consists of frosted glass. A camera underneath the table detects the fiducal markers on the bottom of the tangible notes and tracks their positon (see Technical Research: Interactive Table). The programming language VVVV translates the signal visual signal into a sound, which becomes audible.
Also it controls the visual output, which gets projected onto the frosted glass from underneath the table using a mirror.

The user's reflection on their action isn't necessarily compulsary in the standard mode, but an exercise mode with tutorials sorted by topic and stage is enabling that. Therefore learning is enabled, if the learner reflects on the physical action, builds a mental concept of how to achieve the goal set by the exercise mode and connects that knowledge to the fact, that this is how this abstract language works.

The installation seems successful to me, because the visual language used is straight forward. Notes are immediately associated with music and and most people are familiar with the concept of a musical scale - not necessarily the connection between visual and sound. The installation closes the link by explaining note values, note scale and their relationship.

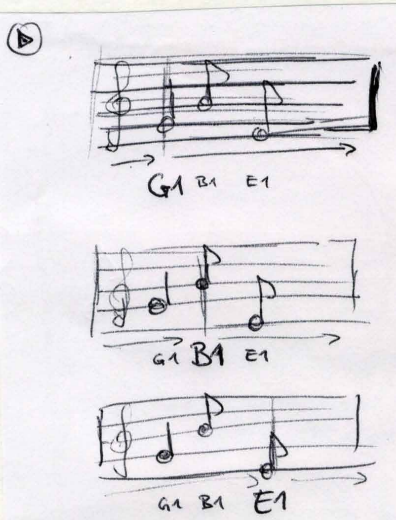
I've been trying to get into contact with the designers via email to ask them which studies they based their installation on, if there are studies that can prove the success of their project, which age group the target audience is, and if their project is currently exhibited somewhere. Unfortunately, I didn't get a response.



Placing the physical notes directly onto the stave will give an immediate visual and auditive feedback.
By changing its position, the feedback will vorrate:
→ placing it higher leads to a higher pitch tone as auditive output and will lead to a change in the visual feedback.
→ placing it lower " " " lower " " "
→ placing it differently horizontally doesn't lead to a difference in the auditive output, but will change the position of the visual feedback in same way

Adding a second, third, ... note, won't change the visual representation of the existing notes. By hitting the ▶ or ⑤ button, the user will realise a hear an effect on the sequence though, therefore the auditive feedback.

By placing notes with different values, the user will realise, that this has an effect on the auditive feedback.



When the ▶ Button gets selected the sequence is visualised by a vertical stroke on the scale going from left to right, representing the position of the note being read. The auditive feedback playing the note at the position of the stroke. And the 'name' of the note is presented by a bigger fontsize as it is being played.

The position of the vertical stroke also gives an idea about the note values by jumping slower or quicker from note to note. This reveales, that the distance between the notes does not have an influence on the lenght a tone gets played, but only the note value does.

Transgenic Bestiary

by Nicolas Myers

"Transgenic Bestiary is a game that envisions the use of animal DNA to discover biodiversity, understand taxonomy and create imaginary collections of virtual hybrids."

(www.studiomyers.co.uk)

The installation is devided into three sections:
- The 'tree of life' shows different animal species, which are exisiting on the planet, represented by icons. It shows their taxonomic relation of species in a tree diagram. This states the rules of the game for the 'interactive area'.
- The 'interactive area' consists of wooden blocks, again with animals in icon-representation on it. These can be placed in the highlighted area. The choice of the 'animal' has an influence on the visuals on the monitor. The sequence of 'animals' creates an image representing the combination of those animals. By combining animals that are not related in the 'tree of life' will lead to the 'animal's death'.

GMX

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: myers.nicolas@gmail.com
Kopie:
Betreff: Curious student looking for answers
Datum: 22.10.2012 12:24:05

Dear Nicolas Myers,

My name is Moritz von Burkersroda and I'm studying Graphic Information Design in my third year at the University of Westminster. For my Final Major Project I would like to design an interactive installation, which could ideally be used as an additional learning tool (for children).

Last Thursday I went to see the display of Jason Bruges '21st Century Light Modulator' at Southbank. I met Ross Cairns, who participated at the project as a programmer. It was very interesting talking to him and gain some insight about the project. After telling him about my particular interests, he was suggesting to get in contact with you.

Is it right that you are working on a project for the Science Museum right now?

I had a look at your website and the projects 'Transgenic Bestary' and 'Exclusive Power Club' sparked my particular interest. If possible, I would be very happy to come around and discuss your work with you - or even better: gain some work experience. I'm not after any money, it would just help tremendously for my FMP and my development as a designer.

Looking forward hearing from you!

Yours sincerely,
Moritz von Burkersroda

The installation seems an engaging way to experience the possibilities in science nowadays and encourages critical thinking about its achievements. The visual language also seems straight forward to most adults - who the installation is aimed at. Icons and tree-diagrams are known representations. The lighted up circle in the 'interactive area' hints on placing the wooden game-blocks there, which is supported by an immediate visual feedback on the screen. The printed examples show the aim of the game.

I've been getting in contact with interactive designer Nicolas Myers and we met for lunch. The contact was able through a Programmer (Peter Cairns of The Workers), who I met at the launch of Jason Bruge's '21st century light modulator' at Southbank Centre this year. We had an interesting discussion about his work, my ideas for my project and about interactivity in general. He was very helpful in showing me technical interactive tools, like reacTIVision, The Leap and the possibilities of Processing and Arduino. Also he offered me to get in contact with him if I have any problems with my project.

GMX

Von: Nicolas Myers <myers.nicolas@gmail.com>
An: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
Kopie:
Betreff: Re: Thank you!
Datum: 20.11.2012 16:54:47

You're welcome. Let me know how you're getting on.

Best,

Nicolas

On 20 November 2012 14:13, Moritz Burkersroda, von <m.v.burkersroda@gmx.de> wrote:

> Dear Nicolas Myers,
>
> I just wanted to thank you again for taking the time for me yesterday. I really enjoyed our conversation and you gave me some greats inspirations for my project development.
>
> I hope I didn't take up too much of your time.
>
> Thank you,
> Moritz von Burkersroda

The Magic of Photosynthesis

at Jacob Ballas Chridren's Garden, Singapore

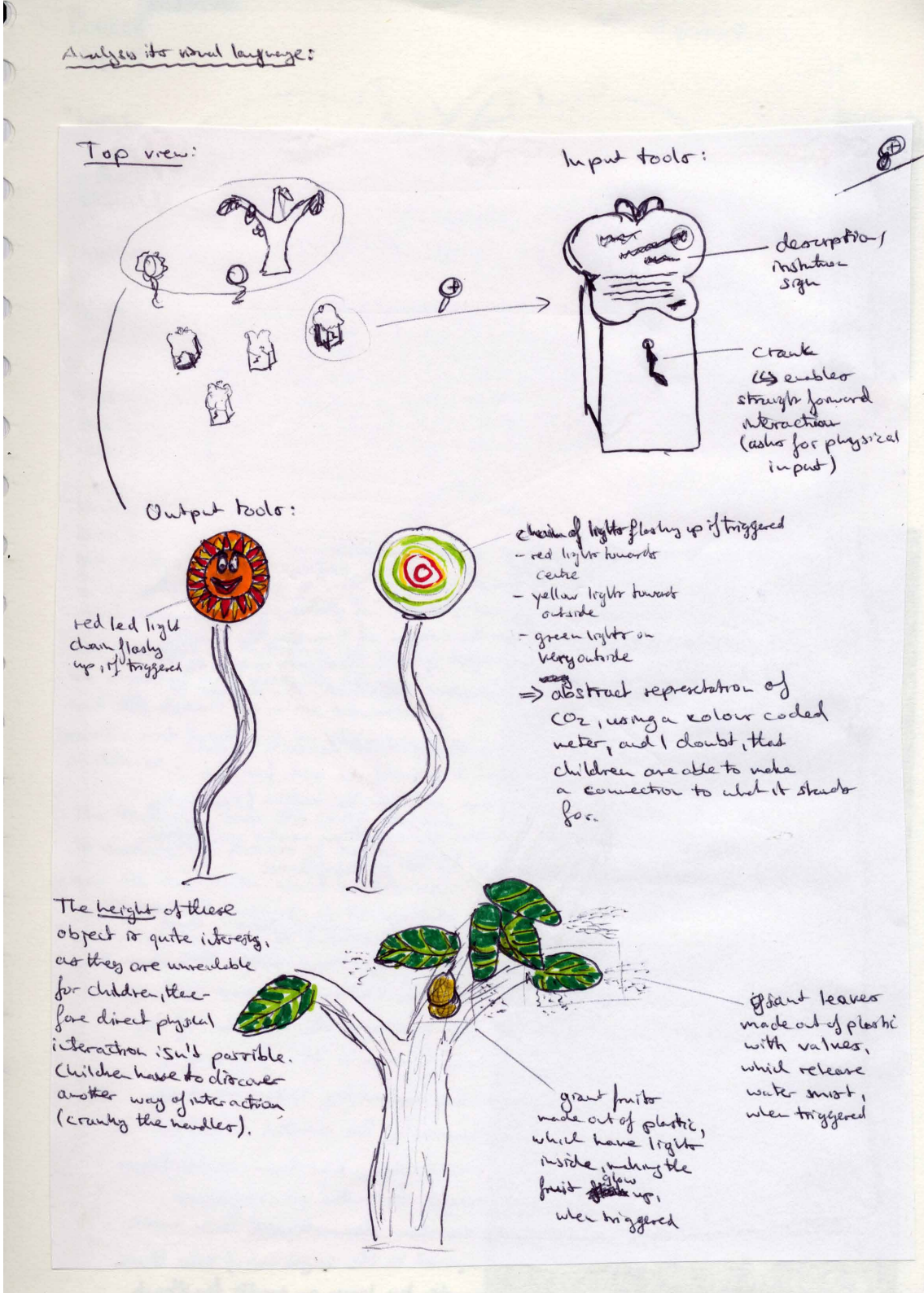
"Jacob Ballas Children's Garden is Asia's first children's garden. Dedicated to all children of Singapore, it is designed to provide a unique discovery and learning experience in garden settings."

(www.sbg.org.sg)

'The Magic of Photosynthesis' is an exhibit aiming to explain the process of photosynthesis to young children (up to the age of 12).

There are four different stations on the installation, all three contain handles for interaction, and represent the elements necessary for the plant to enable photosynthesis:
- cranking the handle on the 'water-station' will leard to water moving up the pipe on the stem of the plant, which comes out the giant plastic leafs as mist.
- cranking the handle in the 'light station' will cause the light chain around the plastic sun to light up.
- cranking the handle on the 'carbon-dioxide station' will lead to

VISUAL RESEARCH



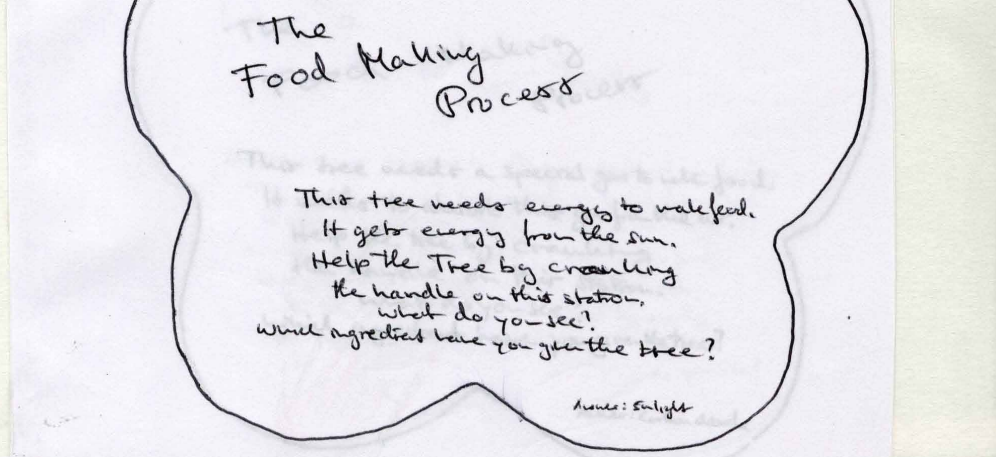
the light chains around the 'meter' flash up.
- cranking the handle on the 'photosynthesis' station will represent the result of photosynthesis by letting the giant fruits in the tree light up.

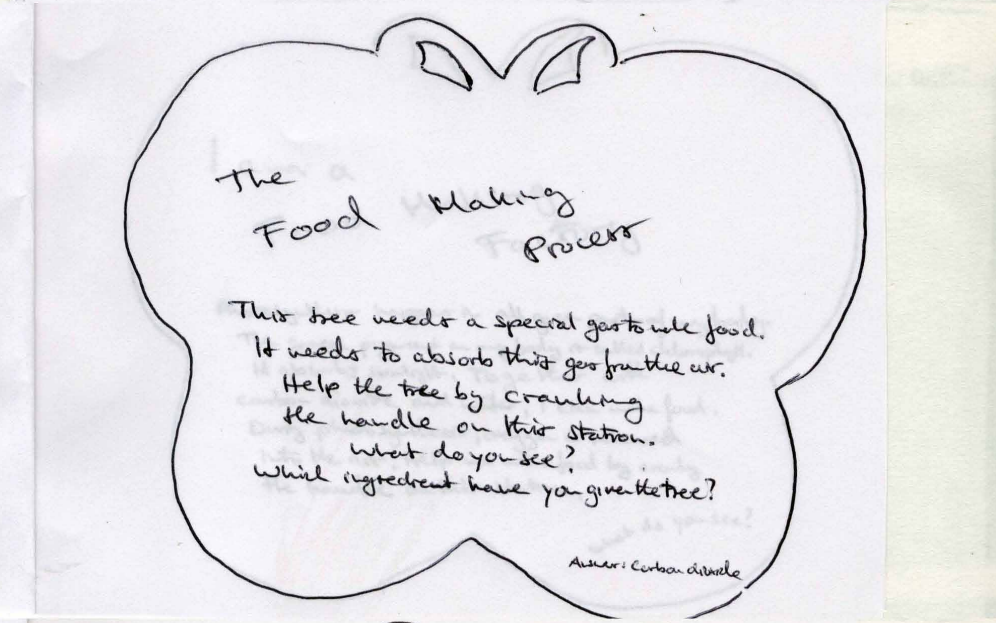
The instruction/description sign works like an informative quiz. First it gives further information about the process, then it instructs the action of 'cranking the handle' and observing the result. A question on the sign asks about the observation. The answer is given in the corner.

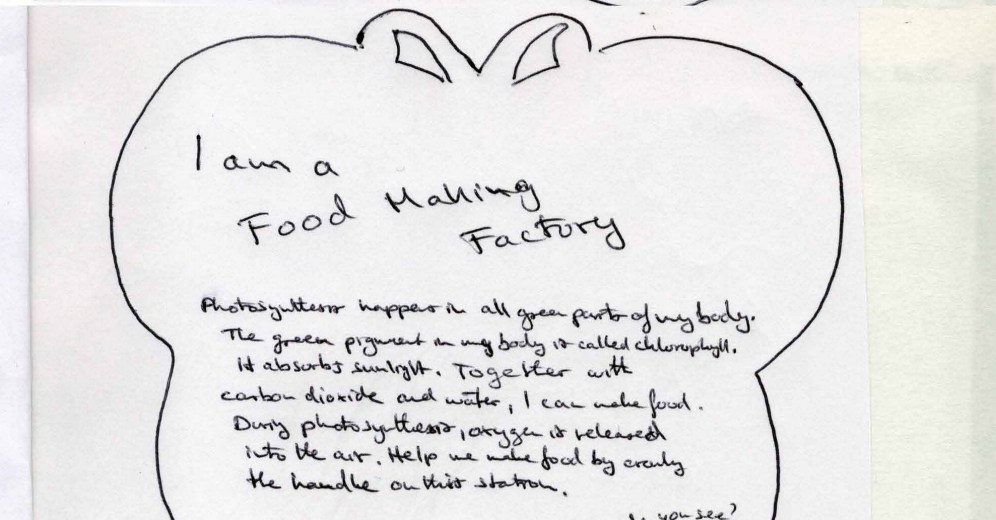
To understand the whole context, the child needs to be able to read, and connect the observation back to the text. The quiz-question serves more as a checkup, if learning has taken place and the visuals more as an aid to the text.

Using handles is a good way of hinting on phyiscal ineraction. Together with the colourful hand painted boxes and giant representations of the elements they seem attractive to children. Nevertheless, the representation of CO2 is confusing, as the children might not understand, what the meter represents.
Suggesting a fourth station for 'photosynthesis' seems confusing, as it might be interpreted as a fourth element needed for the process, rather than the process on its own. Instead, the use of all three stations simultaneusly would have been a better approach to understand the concept.

I tried to get in contact with the organisation to receive information about the designer. Unfortunately, I did't get any response from them.





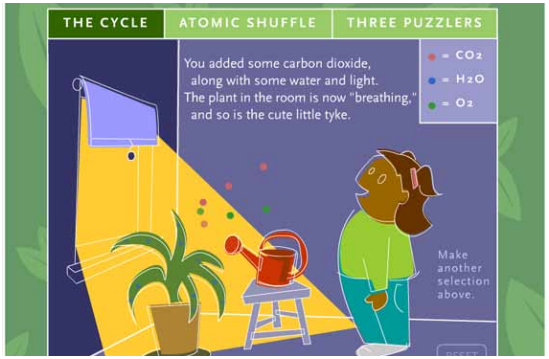


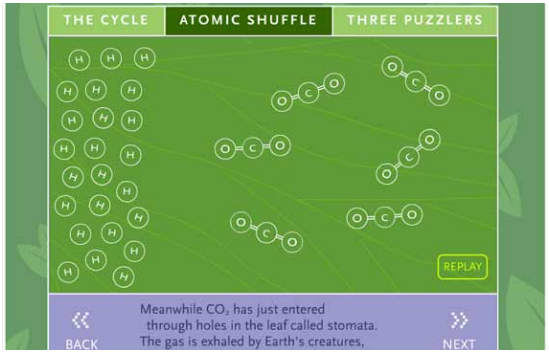
Illuminating Photosynthesis

by Rick Groleau for NOVA Program

"Here, take a look a the oxygen/ carbon dioxide cycle and the process of photosynthesis. Explore how photosynthesis works by helping the process along in this game."

(www.pbs.org)





'Illuminating Photosynthesis' is a Flash-based game available online, aiming to explain the process of photosynthesis in a playful way. It consists of three little games: 'The Cicle', 'Atomic Shuffle' and 'Three Puzzlers'.

'The Cicle' shows an image with 3 objects, each starting an animation when clicked. The animation visualises the origin of the three elements needed for photosynthesis: light (added by opening the window blinds), water (added through pouring out the watering can) and CO2 (added by letting the person breathe out). The elements are then presented by moving, differently coloured circles, which are explained by the key in the image.

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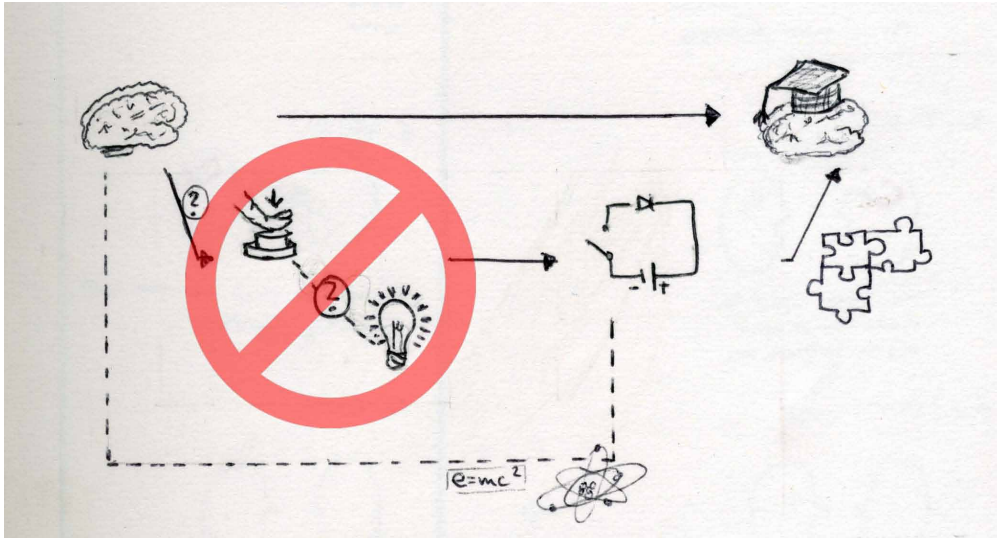
'Atomic Shuffle' is visualised by a perfective, animated story through which the user can skip (Next, Back or Replay button). By zooming into an image of a tree, into a leaf, then its cell, where you can eventually find simplified chemical bonds. Their reaction during photosynthesis then gets explained in a step-by-step animation. Each step is explained further in a paragraph underneath the image.

'Three Puzzlers' is a quiz consisting of 3 questions, which can be answered by clicking on 'Yes' or 'No'. The answer then gets explained. The questions contain three facts about photosynthesis, but couldn't be explained just by completing the first two games. They rather contain additional information.

'Illuminating Photosynthesis' works like an interactive schoolbook. The concept of photosynthesis is simplified and explained step-by-step, which helps to understand the concept. 'The circle' is great to identify oneself with the content by putting it into a day-by-day context. The idea of zooming into the tree as a next step to get an idea that something is happening inside the leaf, again helps to relate it to the first game.
Nevertheless there is no experiencing of the process, rather than getting told what is happening. The user can't shift around elements of the chemical bounds for example and see which elements react together. Taking the element of experiencing a problem, that isn't explainable by current knowledge might never occur, as they get solved anyway. Therefore learning in a constructivist way might not occur.

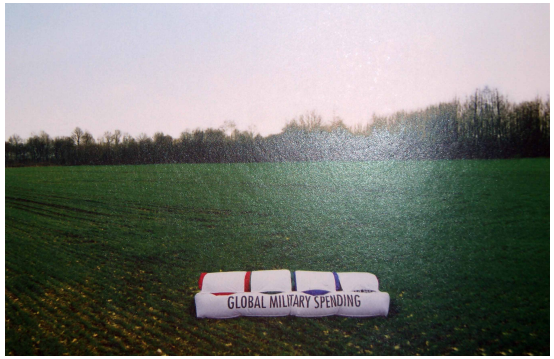


Data Flow 1 & 2

by Gestalten

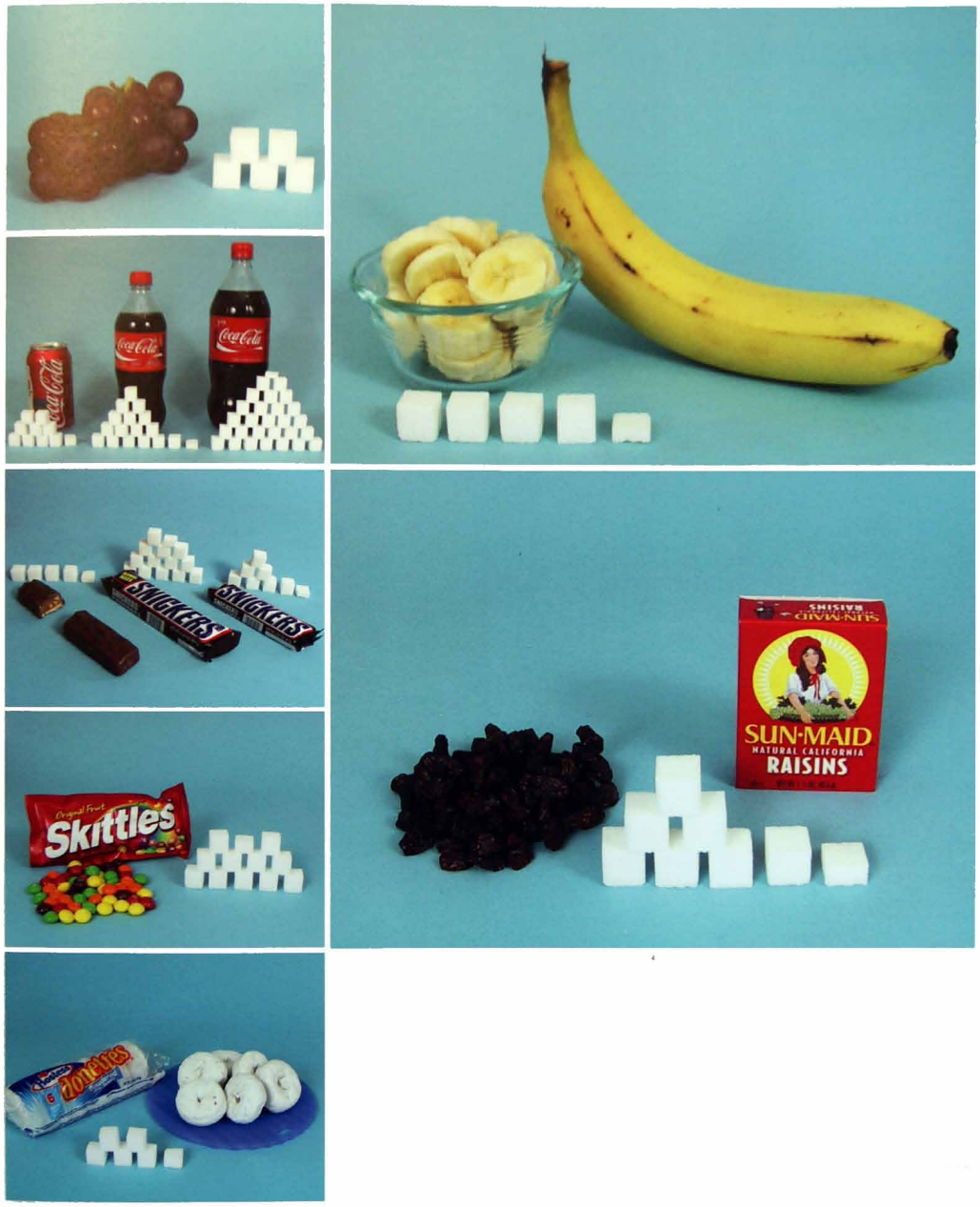
“Visual Metaphors are a powerful aid to human thinking. Diagrams, data graphics, and visual confections have become the language we resort to this abstract and complex world. They help us understand, create, and completely experience reality.”

(Data Flow, Gestalten)

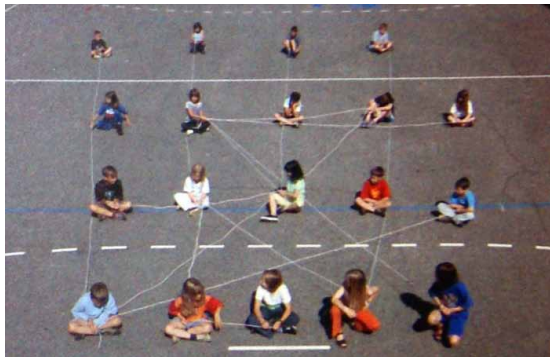


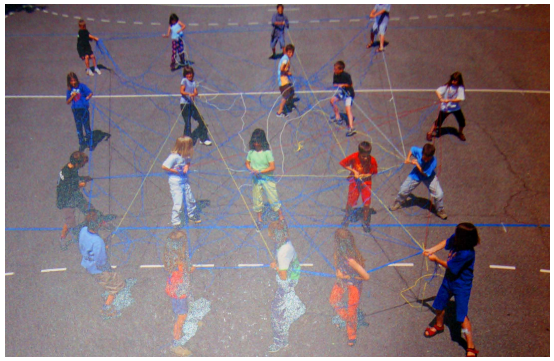
The DataFlow-books gave me some great ideas, what ways there are of visualising an abstract content. Diagrams and pie-charts are well known, but need to be encrypted by the reader first, by putting it into relation. The books show examples that reduce the gap between information and receiver.

Sagmeister designed this blow up version of a physical chart. Suddenly the information becomes relatable to the dimensions of a human.
Similar this example on the right. The ‘invisible’ sugar is put into a cube format, that is relatable again. The comparison between different products reveals the shocking truth.



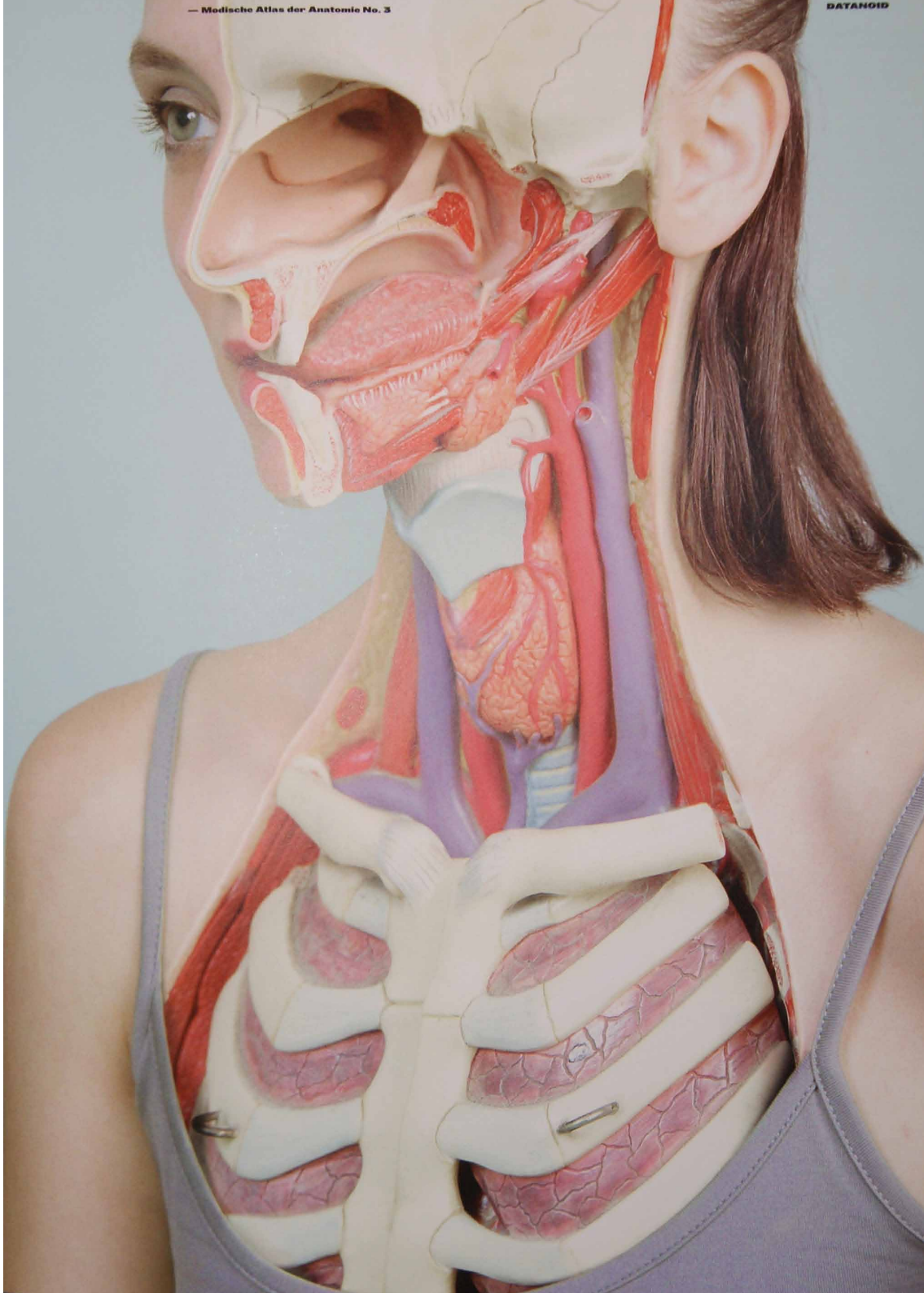
VISUAL RESEARCH





Placing content in its natural environment seems to be an effectful way of understanding it better.
This photomontage of a 'human-dummy' (right hand side) takes the theory of the human body model back to its practice.

Teaching complex concepts to children can be very tricky, as they might not be able to connect it to their current knowledge (see learning theory). Nevertheless they can develop a great understanding by doing.
In this exercise 'Netzwork/Teamwork', students were asked to arrange themselves in a grid structure, and use different coloured strings to show who they would like to be like most, invite to a party, know least well, etc. It is a way of visualising social relationships in a playful way. And obviously easy to relate to that abstract content, even for children.



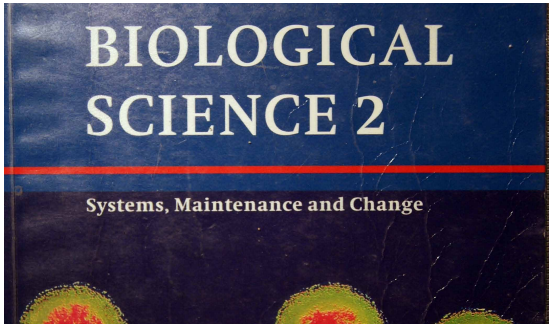
VISUAL RESEARCH

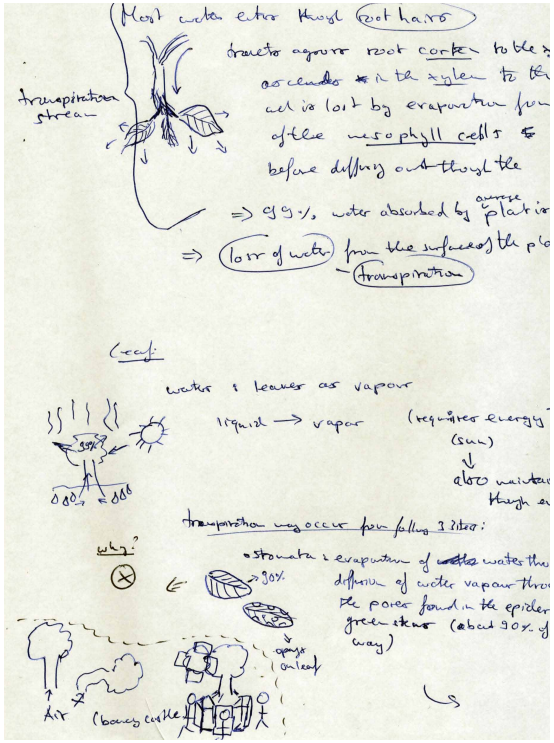
Biological Science 2

by D,J. Tailor, N.P.O. Green & G.W. Stout

"I started making little sketches of each paragraph, so it would be easier for me to remember."

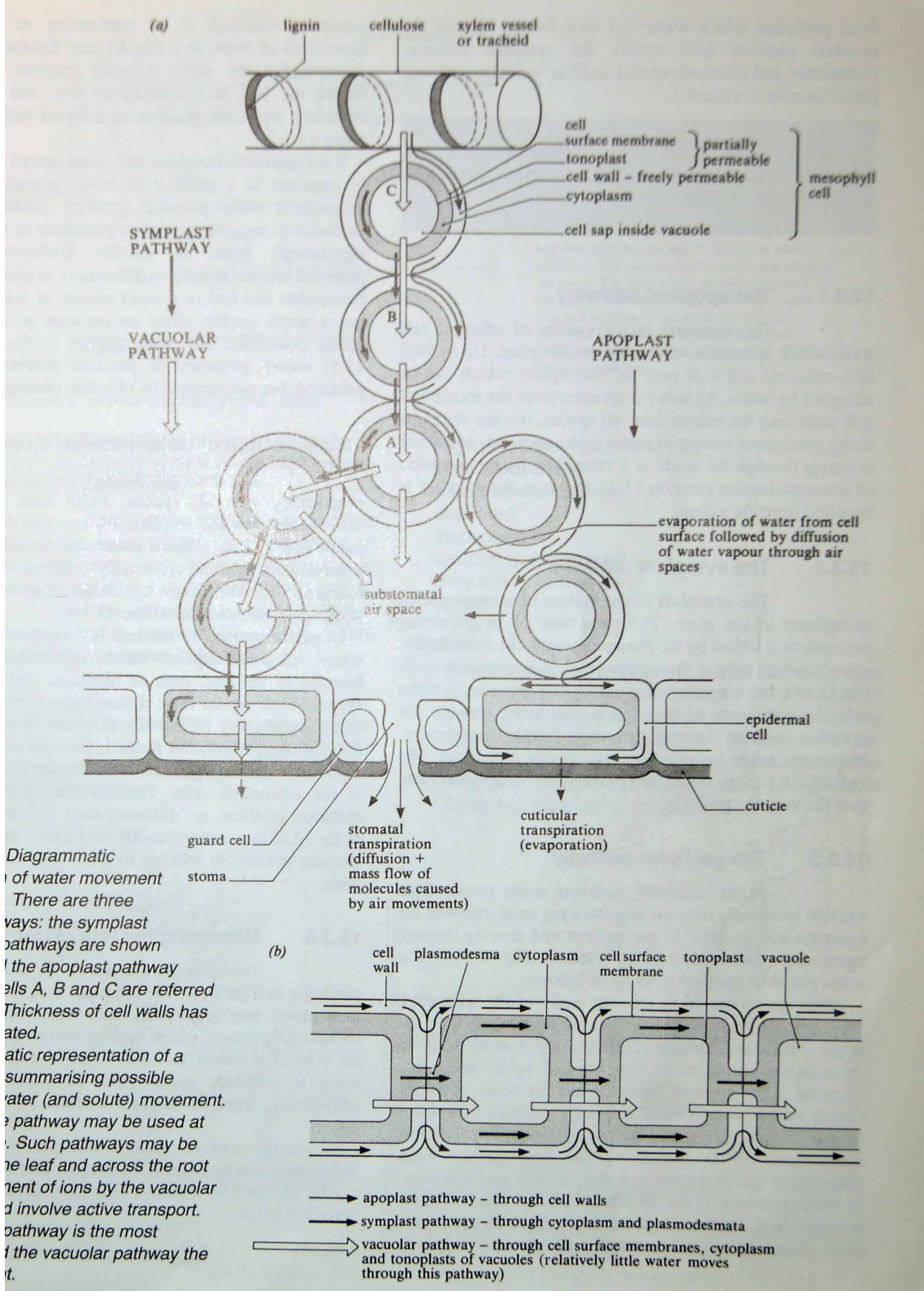
(Moritz von Burkersroda)



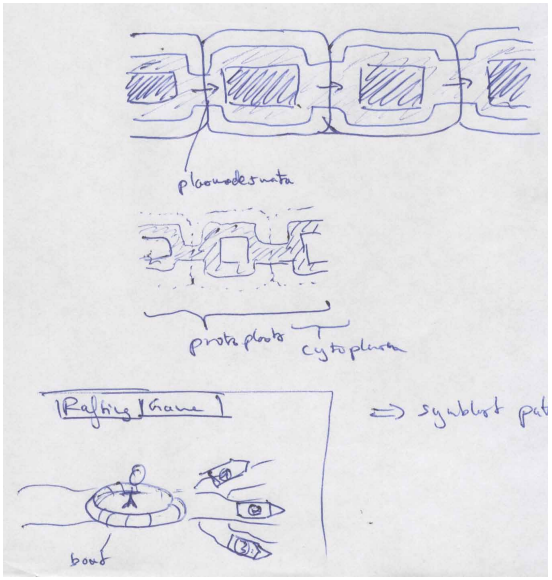


I went to the local library to get some books on photosynthesis. 'Biological Science 2' contained lots of text, and only a few diagrams. Nevertheless, they seemed to help understanding certain concepts.

Each paragraph I read, I summarised in my own words, highlighting the keywords. After a couple of paragraphs I realised, that I already forgot what certain keywords stood for and had to go back in my notes to look it up. This annoyed me after a while. I started making little sketches of each paragraph, so it would be easier for me to remember. Also it helped me tremendously to actually check, if I understood it properly.



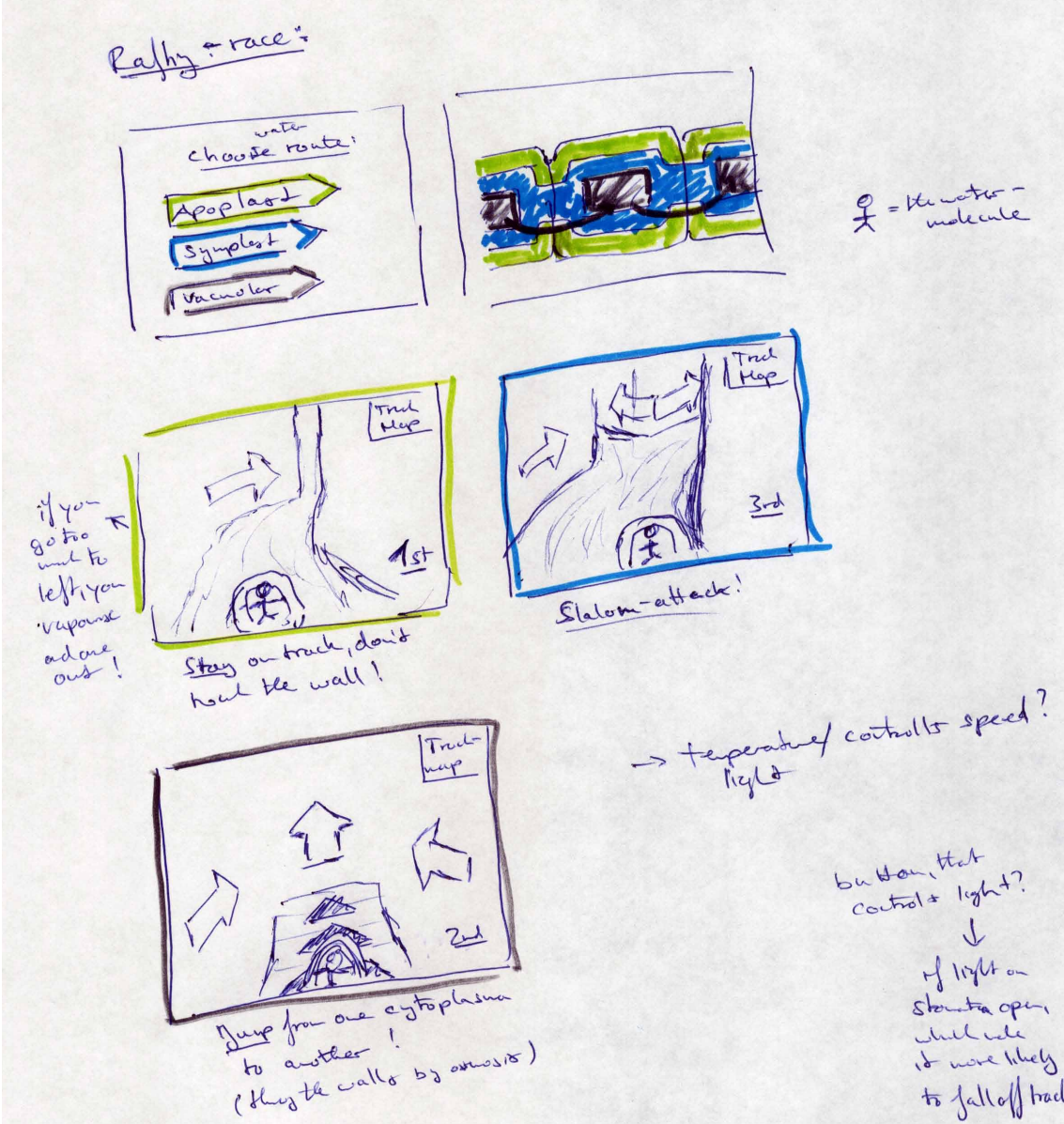
*Diagrammatic
of water movement
. There are three
ways: the symplast
pathways are shown
l the apoplast pathway
ells A, B and C are referred
Thickness of cell walls has
ated.
atic representation of a
summarising possible
ater (and solute) movement.
e pathway may be used at
. Such pathways may be
he leaf and across the root
nent of ions by the vacuolar
d involve active transport.
pathway is the most
l the vacuolar pathway the
t.*



There wasn't much variety in the diagrams. All in black and white, using geometric shapes, when possible, and still a lot of technical terms in them. I wondered if there was a way to go away from that format. Maybe by adding colour, making it 3D or even physical, animating it, or converting it into a game.

One of the topics the book was touching was the transpiration of water through the leaf. Basically, there are three ways the water can be transported through the leaf, each of the ways has their advantages and disadvantages considering speed, energy used ,and the likelyhood of vapourising out of the leaf.

Instead of having three diagrams explaining it, the process could also be explained using a racing-game, in which you choose your pathway and playing against other participants. This would make the content more enjoyable and the player would learn about the concept by experiencing it.

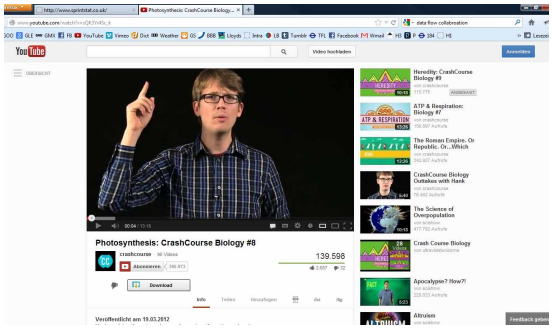


CrashCourse Biology

by Hank Green, Blake De Pastino & Amber Bushnell

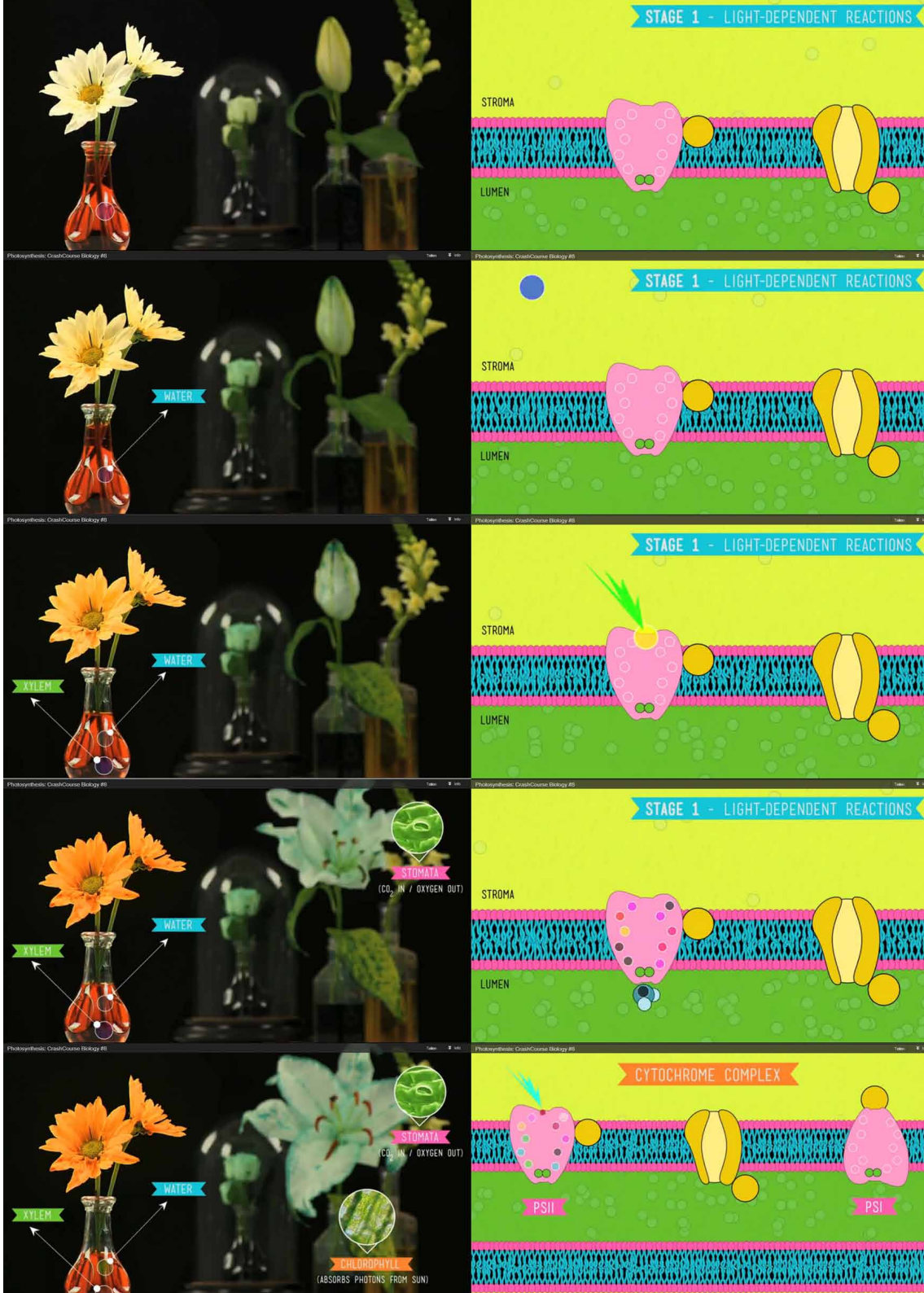
"PHOTOSYNTHESIS! It is not some kind of abstract scientific thing; YOU would be DEAD without plants and their magical... ney...scientific ability to convert sunlight, carbon-dioxide and water into glucose and pure, delicious oxygen."

(Hank Green, Director/Instructor)



I came across this YouTube-video, which is part of a series called 'CrashCourse Biology'. The presenter uses informal, direct speech with the viewer (clearly to attract students), as well as animations to support the content visually. Since it's part of a series it allows to jump back to other chapters, which are related, by using YouTube-links.

Most graphics are similar to the ones found in schoolbooks, but animated. This enables to reveal information step by step, which makes it easier to understand, as knowledge builds up on another. As a starting point (explaining how water, CO2 and light gets into the plant), they used an everyday reference: a time lapse of a real plant in a vase.



VISUAL RESEARCH

Involving Experts

emailing Professionals

In this chaper I want to remenisc over all those emails, that have been forgotten. May you rest in peace in this cruel world of cyber-technology.

To expand my research in photosynthesis, interactivity and learning, I've tried to get in contact with many professionals via email. Some of them got back at me and were really helpful in the development of my project. Others never replied and were hard to get hold off. Here a list of people and institutions, I tried to contact for this project, but haven't mentioned yet:

- Jason Bruges, Interactive Designer
- Lyn Modaberi, Head of Design, Science Museum
- South London Botanic Institute
- Children's Museum Manitoba, Canada
- Prof. Angela McFarlane, Director of Public Engagement and Learning, Kew Gardens
- Prof. Tony Ng, Richard Dimbleby Professor of Cancer Research, King's College

An: tony.ng@kcl.ac.uk
Kopie:
Betreff: Interactive Installation on Photosynthesis
Datum: 29.11.2012 12:53:16

Dear Professor Tony Ng,

I am currently designin
audience. Therefore I'

It would be most helpf

Von: Childrens Museum <noreply@childrensmuseum.com>
An: m.v.burkersroda@gmx.de
Kopie:
Betreff: Your comment has been submitted
Datum: 25.11.2012 13:40:30

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: NPARKS_SBG_Visitor_Services@NPARKS.GOV.SG
Kopie:
Betreff: Interactive Installation on Photosynthesis
Datum: 29.11.2012 16:59:10

Dear Sir or Madame,

I am currently working on an interactive installation elucidating the proces
Therefore I'

I came acros
it in my rese
Unfortunatel

Is it possible

Thank you f

Regards,

Moritz von I

Graphic Info
University o
London

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: mail@jonasheuer.de
Kopie:
Betreff: Noteput - Bachelor Projekt
Datum: 26.10.2012 12:37:33

Sehr geehrter Herr Heuer,

mein Name ist Moritz von Burkersroda und ich studiere derz
letzten Jahr an der Univ

Als Teil meines Bachelc
Bildungszwecken in Mu
gefallen, welches Sie mi

Nun frage ich mich, ob
Verbindung mit Museur
nicht viele Informatione

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: rsvp@modulator-project.com
Kopie:
Betreff: VIP reception
Datum: 17.10.2012 17:44:11

Dear Sir or Madame,

my name is Moritz von Burkersroda and I am studying Graphic
the University of Westminster.

I am very interested in interactive installations and particularly
Modulator'. It would be fabulous to learn more about it.

Would it be possible by any chance to receive an invitation to
tomorrow? I would be more than honoured to be part of the ev

Kindest regards,

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: lyn.modaberi@sciencemuseum.org.uk
Kopie:
Betreff: Information Design Final Major Project
Datum: 10.10.2012 17:13:32

Dear Mrs Lyn Modaberi,

my name is Moritz von Burkersroda and I am currently studying Graphic Information Design in my
ed me your email, when I to

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: info@slbi.org.uk
Kopie:
Betreff: Interactive Installation on Photosynthesis
Datum: 29.11.2012 11:52:11

Dear Sir or Madame,

I am currently designing an inte
audience. Therefore I'm researc
deliver the content accurately.

It would be most helpful to add
background and insight of the t
following three: latest research
on the topic.

I would be able to formulate th
be most delighted if you had the

Thank you for your time.

Regards,

active installations for infor
installation that could be us
e Museum.

Von: "Moritz Burkersroda, von" <m.v.burkersroda@gmx.de>
An: A.McFarlane@kew.org
Kopie:
Betreff: Interactive Installation on Photosynthesis
Datum: 29.11.2012 12:21:05

Dear Professor Angela McFarlane,

I am currently designing an interactive installation elucidating the process of photosynthesis to a broad audience. Therefore I'm researching into the topic to be able to deliver the content accurately.

It would be most helpful to add an expert's perspective on the topic – ideally with you. To gain insight the science aswell as discussing ways of delivering it, could push my project a lot further. Obviously I would be happy about gaining information on any of the following three: latest research in the field, visualisation methods of the process and certainly your voice on the topic.

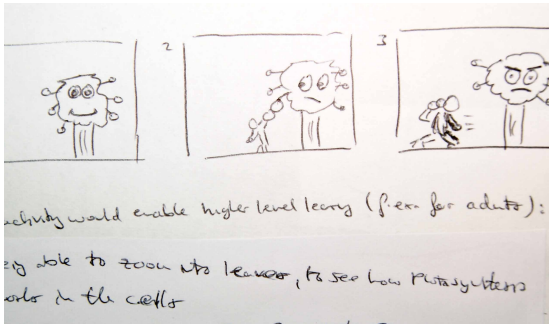
I would be able to formulate thorough questions via email or discussing them by phone. However, I wo be most delighted if you had the time for a personal talk.

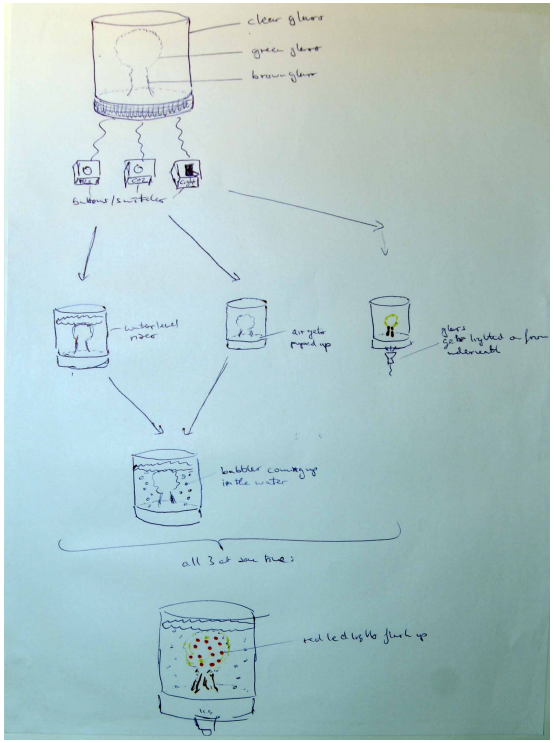
Visualising Photosynthesis

Sketches & Experiments

"We remember 20 per cent of what we hear; 40 per cent of what we hear and see, but 75 per cent of what we see, hear, and do."

(M. A. Bartley, Creative Arts Therapist)

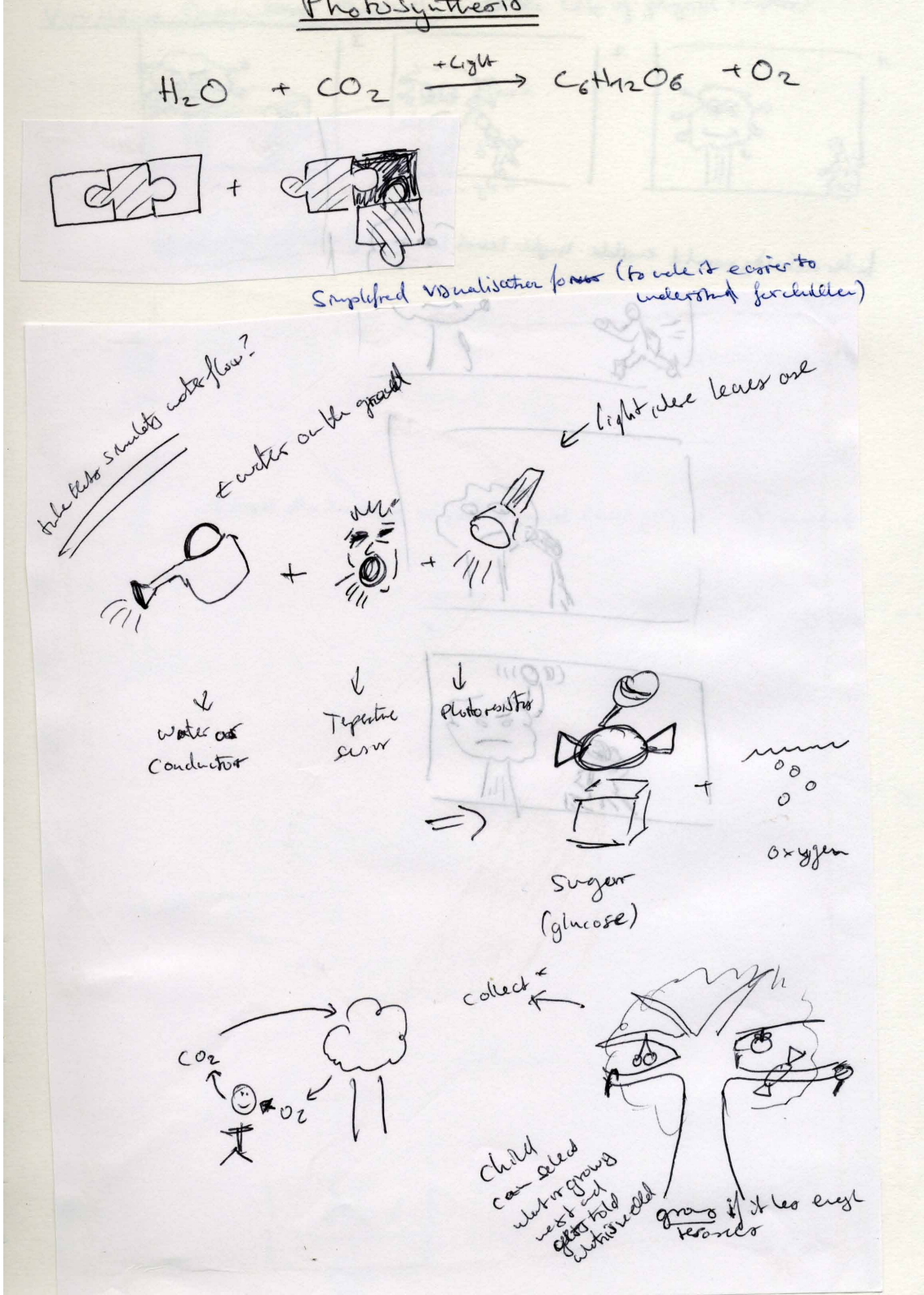




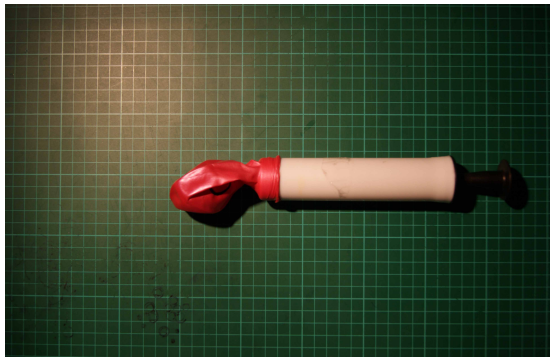
During my previous visual reserach I discovered, that there are many ways of visualising an abstract content. Now it was onto me to apply this knowledge to visualise the concept of photosynthesis.

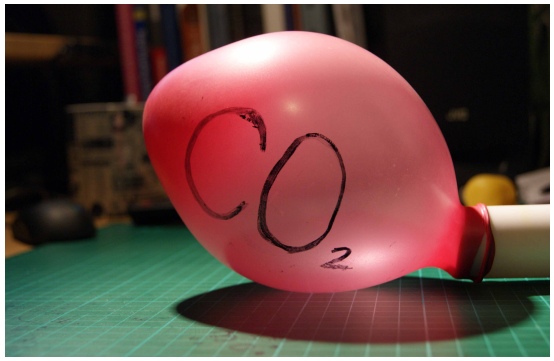
I sketched out different ways to visualise the elements necessary for photosynthesis (water, carbon-dioxide, light) and the products they produce (sugar/ energy) and oxygen.

I used their chemical representation, symbols, diagrams, storyboards ... . The chemical representation seemed too abstract in itself, symbols weren't precise enough and diagrams seemed to need additional verbal explanation, which I wanted to avoid.



VISUAL RESEARCH

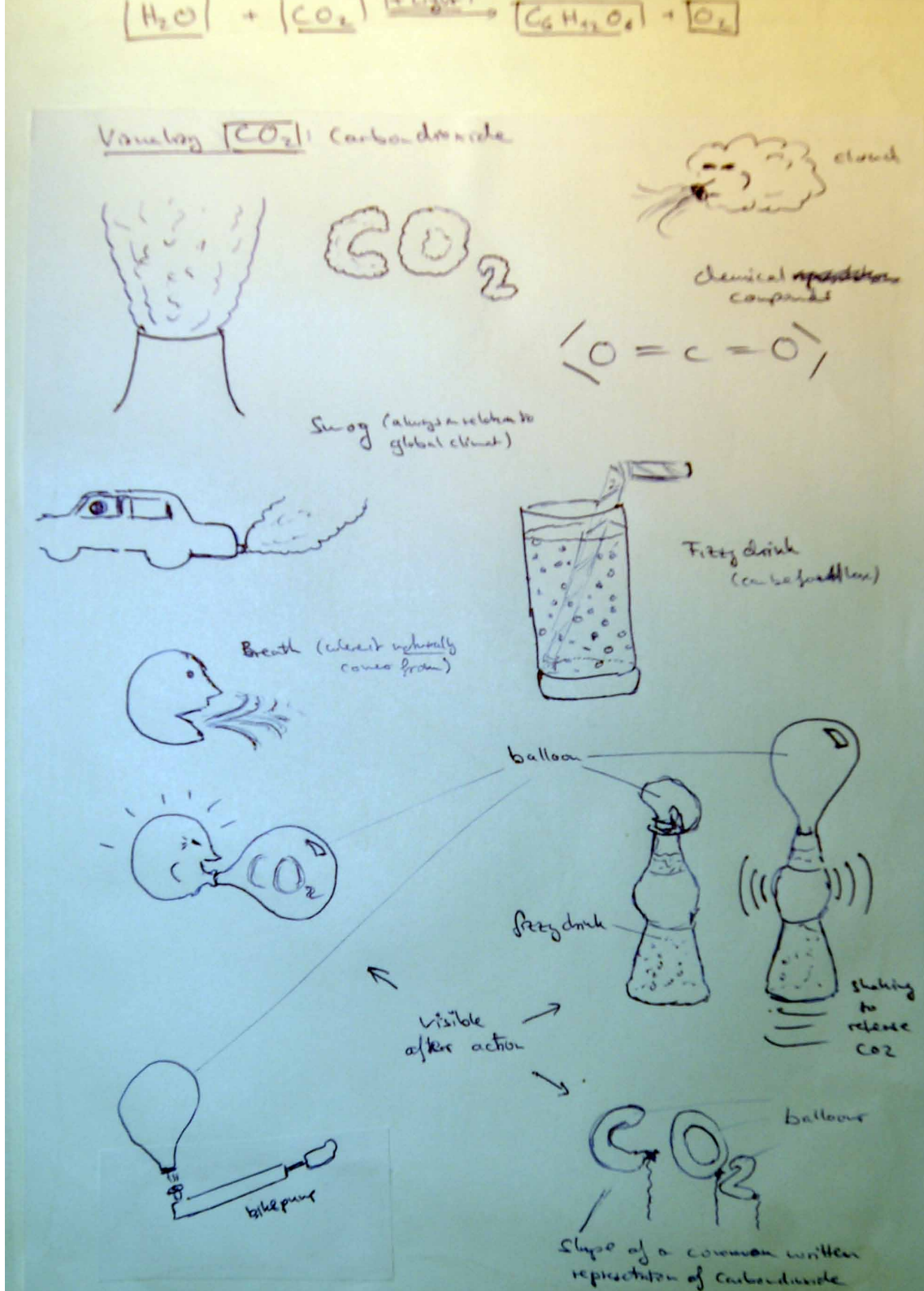


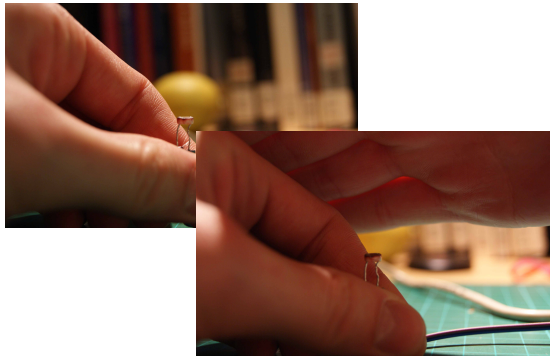


Storyboards seemed to explain the process step-by-step, which seemed to help to structure it, even allow interaction.
Physical, experimental metaphors seemed to make much more sense to me though, as they would be directly relatable to everyone, who knows about the object and it's features. Also they allow the user to experiment and discover the content themselves. As M.A. Barley states it would even become even more memorable if a physical action is involved.

To visualise something 'invisible' like carbon-dioxide, i decided to use a flexible container, like a balloon. By blowing the balloon up with an airpump, it would become visual.

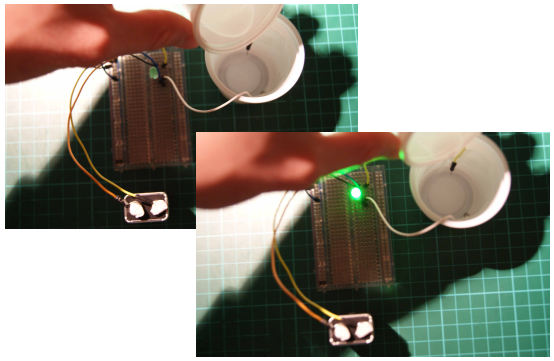
During a TED Talk by Anthony Turner explaining a project 'Making Greenhouse Gases Visible', C02 was represented by these giant bubbles ascending over NYC - a place everyone relates to. Piling the bubbles up covering the city put it into a physical scale. A visual metaphor like that suddenly makes the invisibe danger become real. Showing CO2 in balloon-shape, would help to put it into relations.





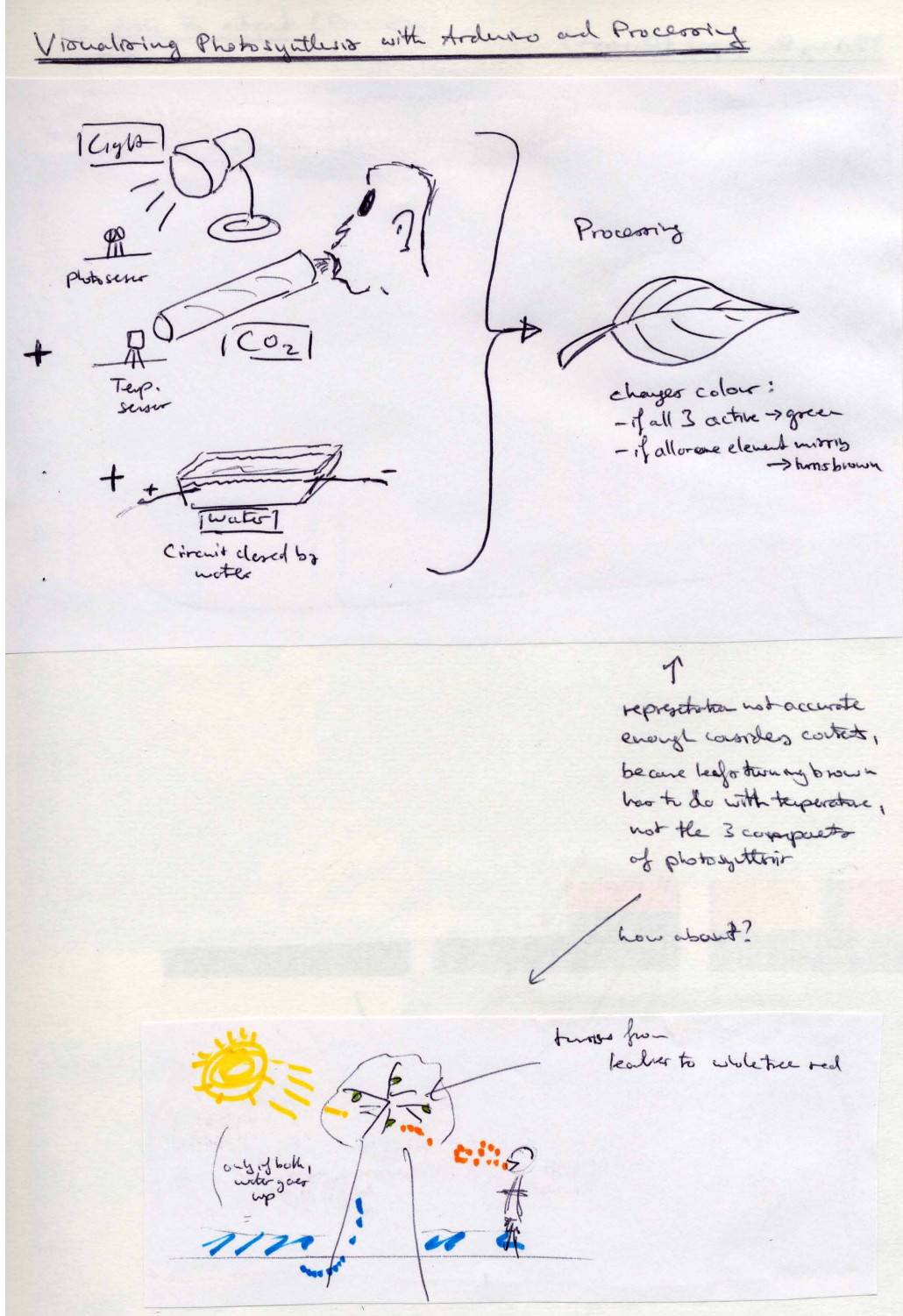
After sketching up some ideas, how to visualise photosynthesis by asking for a physical action, I used my Ardunio Sensors in combination with Processing to test, if it would would work.

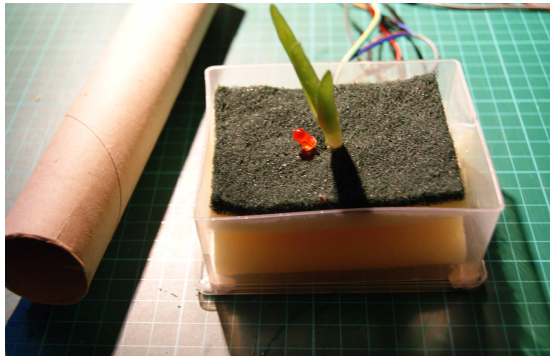
To symbolise light, a lamp needs to be pointing at the photoresistor; for carbon-dioxide input i used a pipe you need to blow in, which get sensed by a temperature sensor; for water, a cup needs to be filled up with water, while water closes the circuit between two leads.

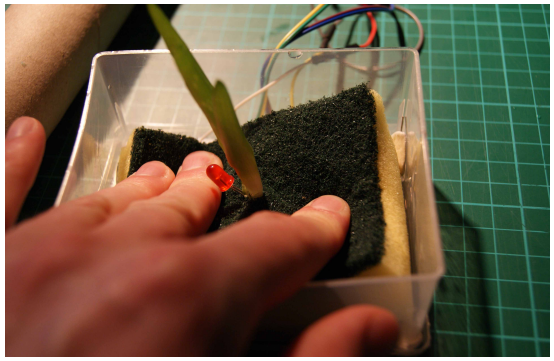


The image programmed in Proessing would then change accordingly to the input. If all three elements are 'available' at the same time, the 'tree' would produce 'fruits'.

The visualisation seemed to be a good start, but definetely needs development for in-, and output methods. How to use the installation needs to be more precise. The output visualisation isn't clear either and needs explaining.



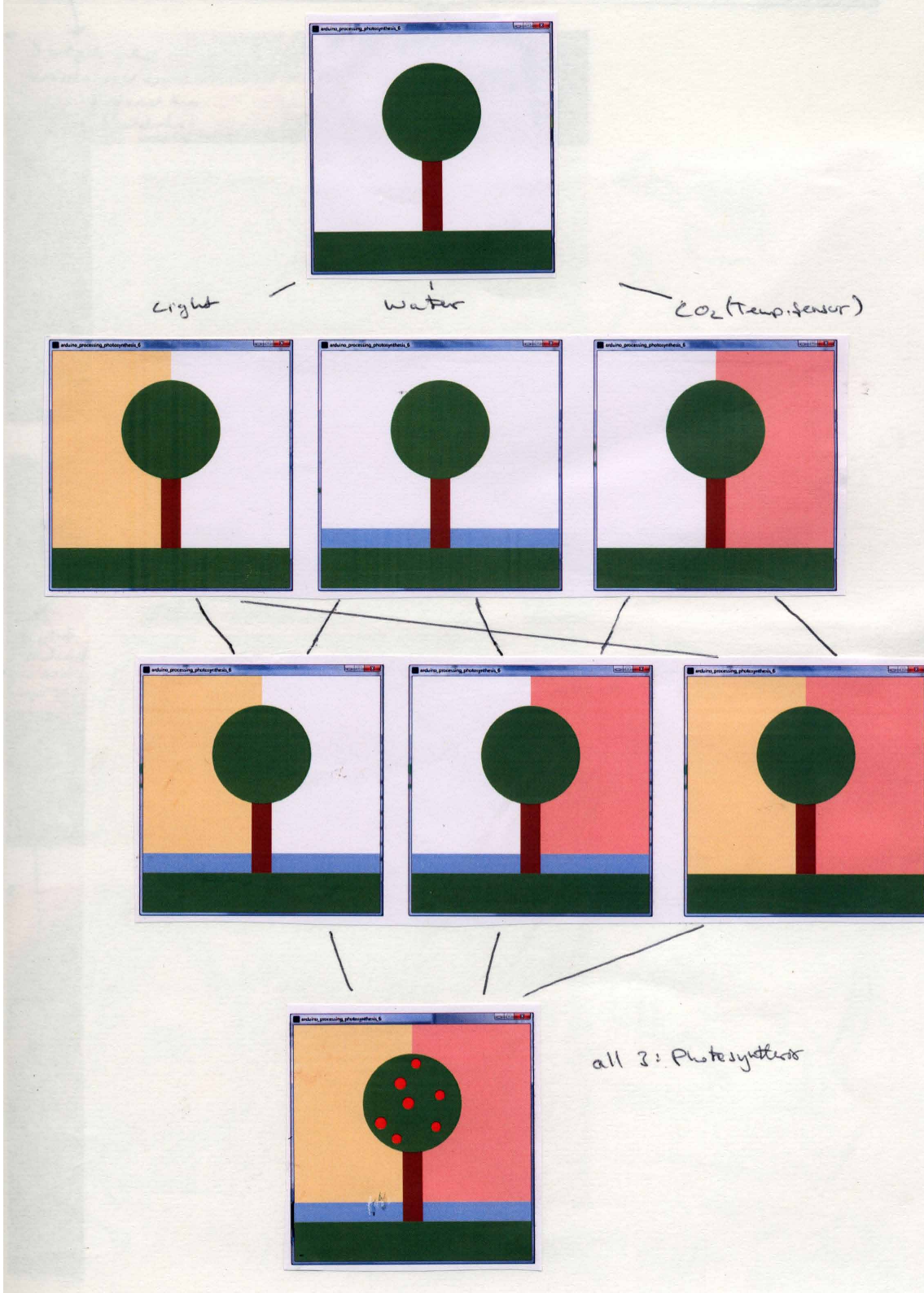




One idea to clarify interaction was to use a sponge with water, instead of a cup of water. A sponge is an everyday object and people, know its features. Pressing the water in and out - and therfore to a and away from the plant, might be a better way approaching that aim.

This made me think, that this might be the way to approach the project in general. By using everyday objects, - which features and ways of interaction would already be clear - and combining the action with the content, learning could be enabled in an experimental, hands-on,and relatable way.

Using objects for input demands to consider the model of Chris Crawford from the beginning. Interaction needs to be clear to the user. It is a great method to engage the user into the content and provide an environment in which learning takes place.



Project Proposal

What

‘Experience Photosynthesis’, an interactive installation, which functions as a visual learning aid to experience the abstract process of photosynthesis in a hands-on way. It allows physical interaction through which the user will learn about the procedures in plants, which are necessary to keep them alive. Different methods of action and their consequences on photosynthesis make aware of the importance of plants in human life.

Why

A lot of processes in the world can today be explained by science. Abstractional thinking has become a powerful language, which helps to break down complex processes and relate them to previously gained knowledge. Unfortunately, this abstractional thinking becomes a boundary to non-scientists to relate to a scientific explaination. Using visual metaphors help to relate to complex scientific content and make it understandable by simplifying it, but usually leads to a comprimise of sacrificing the accuracy of the content. Being able to adapt to the level of the learner could be a way of reducing that comprimise. Interactivity allows this adaption and would therefore enable to pick the learner up, where he/she is.

Photosynthesis is an essential component for life on the planet. Only a small part of the process is visible to the naked eye. The installation enables the user to go beyond that, and experiece the process of photosynthesis as a whole. Based on constructivist learning theory and its connection to interactivity, the installation enables to experience the biological processes step-by-step. By letting the learner set their own learning aim through interactivity, learning becomes informal and encourages to learn more. The content becomes more complex, the higher the learning aim set by the user. Using physical objects enables hands-on experimenting, which leads to a more memorable learning experience. The physical interaction aims to close the gap between abstract and reality, to help the audience better identify themselves with the topic, by making it relate to the user’s action(s).

How

The installation will contain visual metaphors, which will help to relate to the content. This will happen mainly through representation of physical objects, which will ask for a physical action. Iconographic and diagrammatic representations will help to connect the physical to an abstract level, which then enables deeper learning. During the visual research it has been shown, that choosing a physical object will be problematic in terms of interaction, as it asks for a visual languge, that clearly articulates to the user, how the (inter)action occurs. To resolve this problem, the part of the installation in the interaction process becomes bigger, as it comes closer towards user. The technical part of this installation will help to enable smooth interaction, as well as visual directional step-by-step guidance through animation, if necessary. Furthermore, user testing will give explanation how well interaction works.

Part of 'Experience Photosynthesis' will be Processing - a common programming language in visual arts - in collaboration with Arduino - a prototyping platform - enabling interaction through electronic objects. With the help of those, a connection between physical interactive objects and their effect on other objects can be programmed. Technical research proved the potential both components bring to the table, particularly the various possibilities of input (sensor-, button-, voice-control, etc) and output (visual, tangible, auditive) methods. For the installallation sensors to detect the elements of photosynthesis are helpful, therefore photoresistors, carbon-dioxide sensors and possibly a flow sensor. LEDs and servo motors will be useful for output methods.

Context

'Experience Photosynthesis' is a project connecting the areas of learning and interaction design. Since the rise of the 'constructivist museum' which enables learning in an informal way, it is not unusual to find interactive installations in museum. Eilean Hooper-Greenhill published many books elucidating the turn of the relationship between museum and audience, because of a change in the views of what education is. The museum visitor nowadays becomes an active participant in museum exhibits. Interactivity plays a crucual part in this.
Visiting the Science Museum opened my eyes to this field and my relationship to learning in general.

Projects like 'Noteput' by Jonas Friedemann Heuer & Juergen Graef have inspired me to encourage people to learn about topics in a different, more experimental way. Also 'The Magic of Photosynthesis' at Jacob Ballas Children's Garden had an impact on me, as it was taking the educational content back to where it takes place: outside, in a tree. It showed that it is possible to bring abstract concepts closer to children through interaction using appropriate visual language. Nicolas Myers' 'Transgenic Bestiary' signifies, that by almost subconsciously offering rules, aims and playground, learning can be approached as a game. Through successful projects like these, learning is not just possible in an experimental way, but because it offers choice, it becomes informal and therefore much more enjoyable, than at formal educational institutions.

Week 1	Finishing Prototype
Week 2	Testing Prototype on users
Week 3	Finalising sketches for installation
Week 4	Planning & programming of installation Purchase of materials
Week 5	Programming of installation Purchase of materials
Week 6	Building the installation
Week 7	Building the installation
Week 8	User testing
Week 9	Catch up week
Week 10	Catch up week
Week 11	Finishing touches
Week 12	Finishing touches