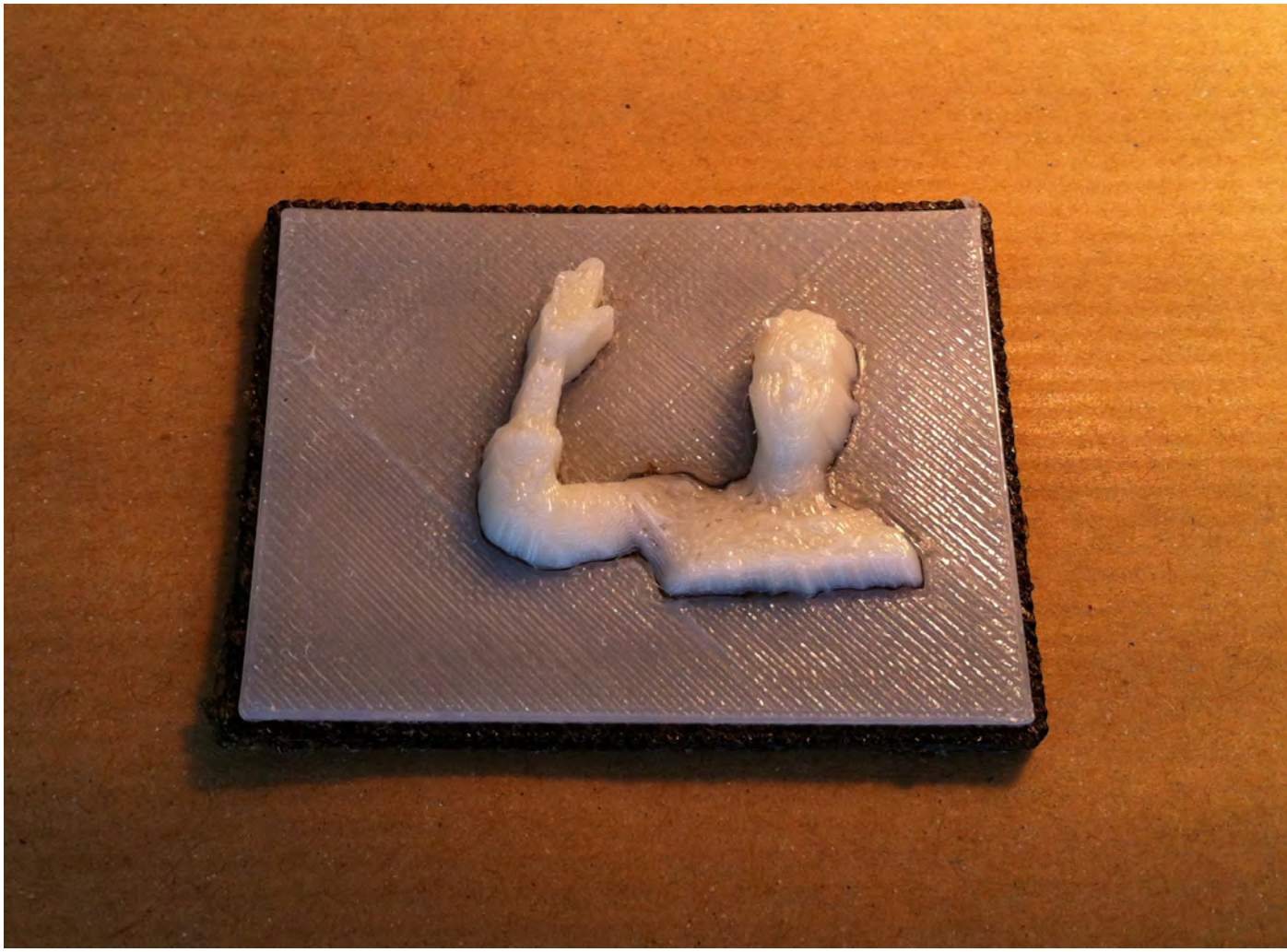
University of Applied Sciences and Arts of Southern Switzerland
Interaction Design Lab

SUPSI

Tasteful Notes
A Service for Mass Customized Edible Prints



Interaction Design Lab
SUPSI-DACD-LCV
Campus Trevano
CH-6952 Canobbio
Lugano, 12 July 2012

supervisor
Fred Voorhorst
SUPSI DACD ICIMSI, galleria 2 - SPS
CH-6928 Manno
fred.voorhorst@supsi.ch

student
Consuelo Keller

table of contents

1 Research Topic Definition

1.1 Research Topic

This project is situated in the field of interaction design, with a particular focus on the topic of mass customization. Whereas customization of products often requires from the customer to somehow contribute to the design process, typically by choosing some features from a predefined list (such as colors, forms, materials, etc.),[1] in this case also other ways of customizing products will be explored, requiring less intervention from the users but still giving them control over the final result.

The area of interest is situated in the field of devices and services related to "scanning" and "printing", both two- and three-dimensional, that act as intermediary between the intangible "data world" and the tangible "physical world". This domain is experiencing a tremendous development and expansion. Technologies that were confined to the professional sector because of high prices and complexity of usage are now becoming more and more accessible to the large public, thanks to a new availability of technology at low cost and to the significant contributions of the "open" movement, providing open and free software and hardware.[2]
Also the exchange of objects, information and emotions among people using these technologies is an important aspect of the project.

1.2 Research Question and Hypothesis

The question is whereas it is possible to create a service based on the new possibilities of 2D and 3D scanning and printing that allows the customers to customize their final product, and capacitate people to exchange messages, convey and express feelings in a personal and powerful way, providing an enjoyable user experience on different levels.

The assumption is that the new availability and widespreadness of technologies for 2D and 3D scanning and printing can contribute to create demand and acceptance for a service where customization and information exchange can be performed using those technologies.

1.3 Research Aim

The aim of this project is to conceive and prototype a service that takes advantage of the new availability and widespreadness of technologies for 2D and 3D scanning and printing and offers to the customers an enjoyable and personal way to exchange information through easy to achieve customization of the final product and a pleasant and seamless user experience through all the touchpoints of the service.

In order to accomplish this, an overview of the current state of the art of devices and services related to "scanning" and "printing" in a wide sense is provided.

The insights of this research constitute the basis for the concept generation of the service, the definition of the touchpoints, and the interaction modalities.
User research will generate insights about their needs and help to identify more clearly

1 See for example the popular NIKEiD service: http://nikeid.nike.com/nikeid/index.jsp (9/7/2012).
2 B. van Abel – L. Evers – R. Klaassen – P. Troxler (eds.), Open Design Now. Why Design cannot Remain Exclusive, BIS Publishers, Amsterdam 2011; http://opendesignnow.org/ (15/5/2012).

the opportunity areas as well as the problems and limitations of the envisaged solutions.

Selected parts of the service will then be prototyped and tested with users in order to evaluate the acceptance and the ease of use of single parts of the service.

1.4 Research Outcome

The outcome of the research is a multi-touchpoint service based on 2D and 3D scanning and printing technologies featuring customization and providing interesting ways to relate with other persons or groups of persons.

The service allows different interaction modalities for different users, tasks and conditions of use. The overall user experience is coherent and seamless through the different channels; the users have the choice between different modalities and possibilities to obtain the final product, based on their needs and preferences.

2 Analysis of the State of the Art

2.1 Topics and Disciplinary Areas

Accordingly to the focus of the project, this section provides an overview of devices and services related to "scanning" and "printing" in a wide sense, with a special attention on methods related to 3D.

Generally speaking, the digital workflow for paper documents began to establish itself since the late 1960s and has been a staple of the modern office since the 1980s.[3] Now the devices for scanning, copying and printing in two dimensions on paper have become very affordable, so that such devices are not anymore confined in the professional domain but are broadly diffused also in the domestic environment.

To digitalize a piece of paper, an image of it is being captured using a scanner. The digitalized document can then be manipulated using dedicated software, or simply duplicated. The result can then be outputted onto paper by using a printer, whereas the choices of different inks and different paper qualities influence the result. Today a printer is often also a connected device with the ability to communicate with other devices, and to the web as well.

A similar workflow is given with digital photography, a domain that is now a widespread commodity thanks to the rapid improvement of the quality of devices and the dropping of prices. The domain of photography has a long history before the era of digital photography, that began to be diffused only in the 1990s. This is not the place for going into details about the history of photography, but it is just important to mention that there are different analogue techniques for reproducing images and that some are experiencing a revival in our digital dominated era. There are also some interesting hybrid services or devices that encompass the digital and the analogue world.

An important domain related to the context of this project is moving from the professional sector to the mainstream: 3D printing and 3D scanning. Technologies that only few years or months ago were very expensive and barely usable by non professionals, are becoming more and more accessible, thanks to a never seen before availability of technology at low prices and also to the pivotal contributions of the "open" movement that provides open and free software and hardware.[4] The digital workflow that is common in the 2D world can now be applied to physical objects.

2.2 Existing/Future Design Solutions, Tools and Technologies (HW/SW)

This section gives a quick overview about design solutions, tools and technologies that are relevant for the project. More importance will be given to the domains of major interest for the work.

2.2.1 2D Printers

Nowadays consumer 2D printers, i.e. devices with the capability to produce text or graph-

3 G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012, p. 302.

4 B. van Abel – L. Evers – R. Klaassen – P. Troxler (eds.), *Open Design Now. Why Design cannot Remain Exclusive*, BIS Publishers, Amsterdam 2011; http://opendesignnow.org/ (15/5/2012).

2.1:
Canon imageRUNNER 3570: multifunction, All-in-One office printer.

2.2:
HP Officejet 4500: wireless All-in-One home printer.

2.3:
Canon Selphy CP810: compact dye-sublimation consumer photo printer.

ics of digital documents on physical supports such as paper, are widespread and also affordable.[5] They are very common in the office domain but also in private homes. Often they are used as local peripherals connected to computers, which serve as document sources. Modern printers often have built-in network interfaces, can communicate to electronic media such as memory cards, or to image capture devices such as digital cameras and scanners, as well as to mobile devices like smartphones and tablets. Most printers can function as photocopiers and often are combined with scanners and fax machines in an all-in-one unit.

There are many different printing technologies: the most common for consumer printers are inkjet and laser printers, both monochrome and color. Dye-sublimation printers are used in the domain of photo printing.

Consumer printers are designed for low-volume, short-turnaround print jobs. The devices are relatively slow and the cost per page is high, but those disadvantages are offset by the on-demand convenience compared to an out-sourced solution. As printers steadily improve in quality and performance, many print jobs which used to be carry out by professionals are now done by users on office or home printers, even in the high demanding photofinishing sector.

2.2.2 Digital Photo Cameras

Another domain steadily improving in quality and performance and dropping in terms of prices is the one of photo cameras.[6] Since a few years ago, the traditional analogue cameras have been supplanted by digital devices, in both the consumer and the professional sector. Consumer digital cameras are produced in a wide range of sizes, prices and capabilities, e.g. the larger and versatile digital single-lens reflex cameras (DSLR) with interchangeable lenses, and the nearly credit card sized point-and-shoot digital compact cameras with fixed lens. They use different file formats for storing image data on memory cards or on internal memory, most of them can connect directly or wirelessly to computers and to printers to transfer data and to print out photos. Some of them have additional features like the capability to capture 3D panoramic photos, or have GPS, compass, barometer and altimeter included, allowing to add extra information to the image data.

Digital photographs can be printed out in many different ways: directly from the camera or other storage mediums (off-

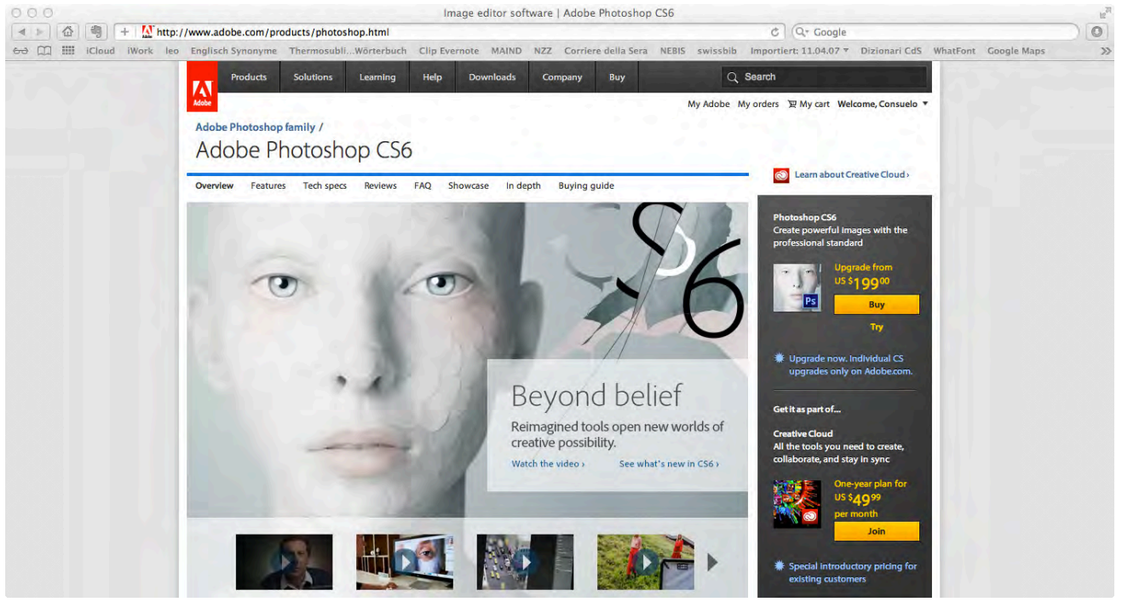
5 See: http://en.wikipedia.org/wiki/Printer_(computing) (15/5/2012).

6 See: http://en.wikipedia.org/wiki/Camera (15/5/2012) and http://en.wikipedia.org/wiki/Digital_camera (15/5/2012).

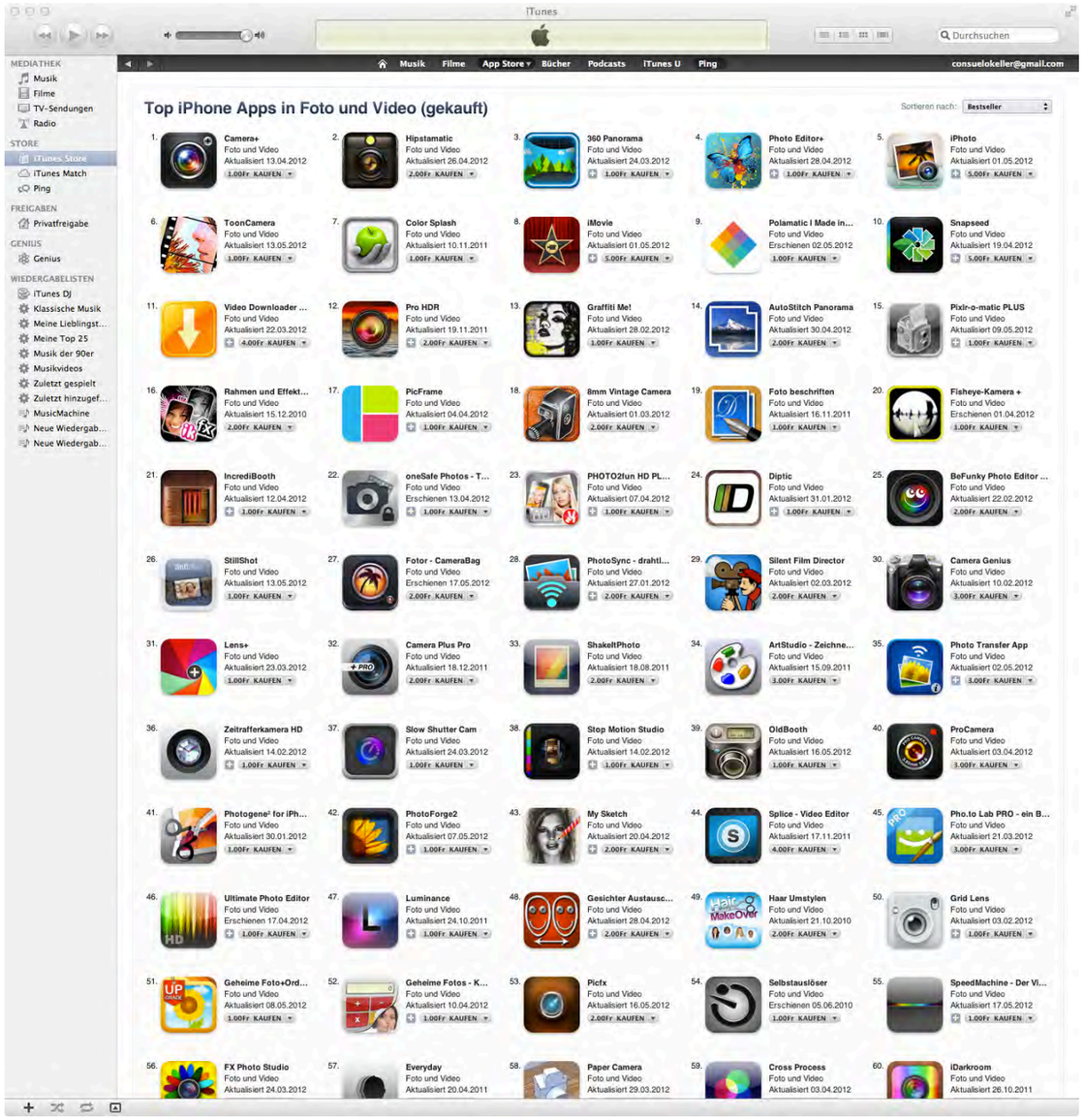
2.4:
Nikon D90: DSLR camera.

2.5:
Sony DSC-TX55: compact digital camera.

2.7:
iPhone 4S with 8-megapixel camera and LED flash.



2.6:
Adobe Photoshop homepage (15/6/2012).



2.8:
Selection of applications for the iPhone dedicated to photography (21/5/2012).

2.9:
Impossible Project new films for old Polaroid cameras.

2.10:
Tintype photographs made by "Photobooth", a studio based in San Francisco specialized in tintype and Polaroid portraits.

2.11:
Photo booth in the streets of Florence, Italy 2012.

line as well as on-line), either on a printer or via on-line printing services.

Digital photographs can also be easily manipulated via professional software like Adobe Photoshop[7] or more accessible software, available also for free.

Digital cameras becoming increasingly cheaper and smaller are today also incorporated into many different consumer devices, the most diffused being the mobile phones.

An increasing number of applications dedicated to photography are developed for different mobile devices.[8] Most of them have capabilities to simplify the action of taking a picture, to enhance the picture quality and to offer possibilities in order to modify the photographs taken. Some of them also take advantage of the additional features integrated in modern devices like GPS and Internet access and also add social and sharing features.

2.2.3 Analogue Photo Cameras

It is important to point out that even if digital devices have revolutionized the way media are produced, stored, shared etc., as described above the "analogue" is not at all dead, as for example happens for the vinyl revival in the context of music. Such evidence is also present in the photography and "print" area. For example, thanks to Impossible Project, a firm producing again instant

7 http://www.adobe.com/products/photoshop.html (15/6/2012).
8 See for example the blog dedicated to applications for the iPhone: http://www.iphoneography.com/ (16/5/2012).

2.12:
"Purikura" booths in a shopping center in Japan.

2.13:
HipstaMart Print Lab for pictures taken with the iPhone Application Hipstamatic (21/5/2012).

films for traditional Polaroid cameras,[9] this analogue photo technique with a rich cultural background[10] is having a revival. Also other lesser known analogue photography techniques, such as tintype, where a photograph is made by creating a direct positive on a sheet of blackened iron metal used as a support for a photographic emulsion, are gaining popularity.[11] What contributes to the fascination of those analogue photography techniques is the uniqueness and the tangibility of the outcome, the process that goes with it, the fact that the pictures are one-off records of the moments captured.

Even if the core of a technique is digital, as it happens in devices such as the modern photo booths, the fascination of having a physical print of a picture, like in the "analogue" days, is unbroken, especially in Japan with "purikura", the photo sticker booths.[12]

Very popular applications for taking photographs with mobile devices (for example Hipstamatic[13]) are also offering analogue print services as one of the key features of their product.

2.2.4 3D Printers

In the domain of 3D printers a revolution is ongoing. Not only the professional devices are getting cheaper and the quality better: there are also several projects which are making 3D printing machines affordable even for private users, with prices even below 1'000.– €.[14] Producers of this kind of machines are for example MakerBot Industries, Bits from Bytes, Ultimaking Ltd., Felixprinters and Delta Micro Factory Corporation.[15] However, it must be pointed out that those relatively cheap 3D-printers are not yet suitable for mainstream everyday use: they all require some expertise and maintenance work, some have to be assembled by the user and the quality is not yet comparable with the results achievable with professional printers. Those devices are still rather for passionate "makers", but the evolution in both hardware and software is so rapid, that it is safe to assume that in the near future 3D printers will be a commodity like 2D printers are today.

9 http://www.the-impossible-project.com/ (16/5/2012).
10 See: S. Crist (ed.), *The Polaroid Book. Selection from the Polaroid Collection of Photography*, Taschen, Köln 2011.
11 See for example: http://vimeo.com/41710130 (16/5/2012), http://www.coolhunting.com/culture/photobooth-sf.php (16/5/2012), http://www.photoboothsf.com/ (16/5/2012).
12 See for example: http://www.photobooth.net/ (21/5/2012), http://de.wikipedia.org/wiki/Purikura (21/5/2012).
13 http://community.hipstamatic.com/hipstamart/print_lab (16/5/2012).
14 An up to date overview with tests is given in: P. König, *Zauberkästen. Sieben 3D-Drucker im Test*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 92–101.
15 http://www.makerbot.com/ (16/5/2012); http://www.bitsfrombytes.com/ (16/5/2012); https://shop.ultimaker.com/ (16/5/2012); http://www.felixprinters.com/ (16/5/2012); http://pp3dp.com/ (16/5/2012).

2.14:
uPrint by Dimension: professional 3D printer.

2.15:
MakerBot Replicator: 3D printer.

Even if 3D printers are not yet in every household, there are other ways for private users to get 3D printed objects in a relatively easy ways: going personally to an open accessible Fab Lab[16] with 3D printing machines, visiting a facility that offers 3D printing, or ordering on-line through professional 3D fabrication services.[17] The latter option allows the users to upload on-line their personal 3D model files (or to choose from already existing 3D models), print the design choosing between a variety of different materials and then ship the printed 3D objects. Popular services are for example Shapeways, Sculpteo, Ponoko and i.materialise.[18]

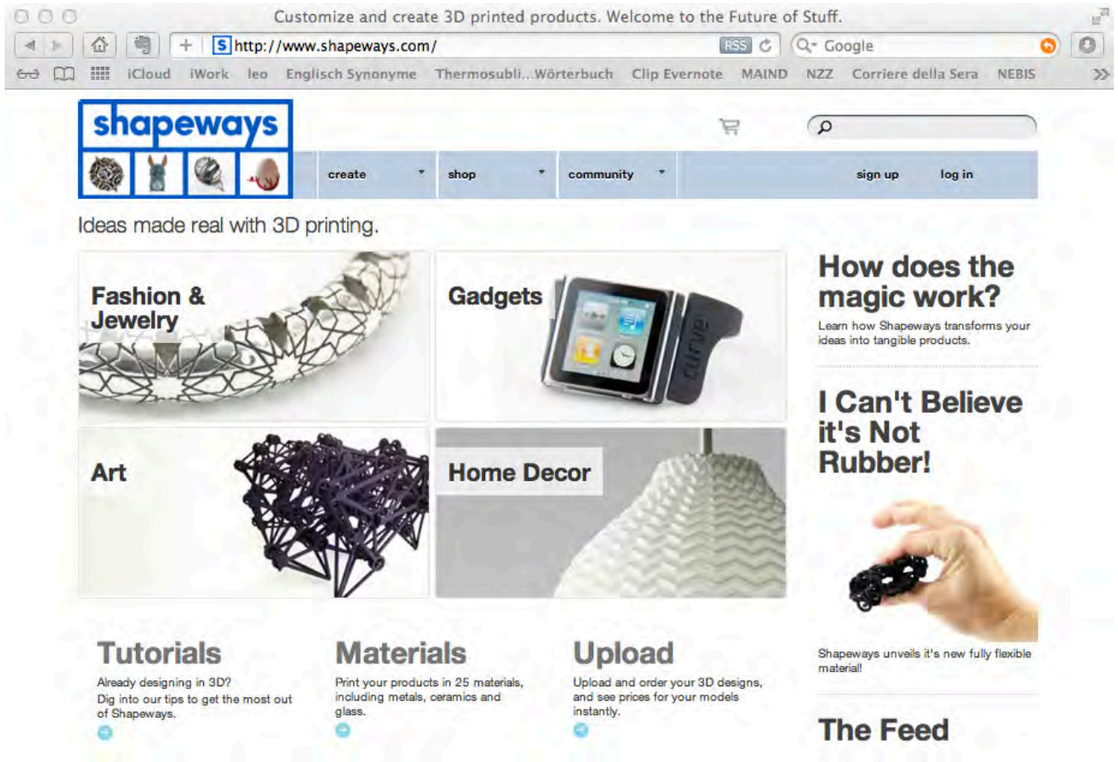
The research on 3D printers also showed that more "futuristic" applications related to that domain are surfacing, providing proofs that scents and microscopic organic tissues and – what is particularly interesting in this case – also food can now be printed.[19]

One example is a food printer concept by Philips Design, a machine that prints combinations of ingredients into shapes and consistencies specified by the user.[20] Foods would be constructed from ingredients corresponding to the nutritional needs of the user, using a process similar to rapid prototyping.

Another similar concept is the "Cornucopia" project by MIT's Fluid Interfaces Group: a consumer-friendly machine that prints food.[21] A three dimensional printer for food, which works by storing, mixing, depositing and cooking layers of ingredients. It has an array of food canisters, which refrigerate and store the user's favorite ingredients. These are piped into a mixer and extruder head that can accurately deposit elaborate combinations of food. While the deposition takes place, the food is heated or cooled by Cornucopia's chamber or the heating and cooling tubes located on the printing head. This fabrication process would allow for the creation of flavors and textures that would be completely unimaginable through other cooking techniques.

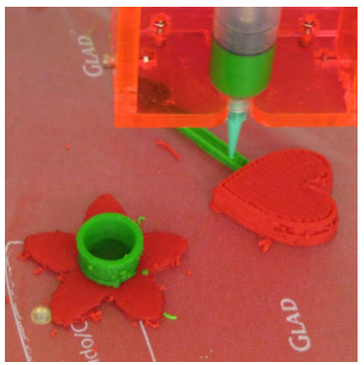
Researchers at Cornell University made some actual tests printing food in 3D.[22]

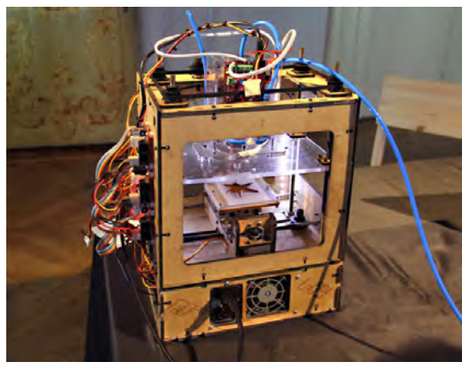
16 http://fab.cba.mit.edu/ (20/5/2012); http://www.fabfoundation.org/ (20/5/2012).
17 An up to date overwiev with tests is given by P. König – A. Barczok, *3D-Druckdieste auswählen*, in: *c't Hardware Hacks* (2012), nr. 1, pp. 134–145.
18 http://www.shapeways.com/ (16/5/2012); http://www.sculpteo.com/ (16/5/2012); http://www.ponoko.com/ (16/5/2012); http://i.materialise.com/ (16/5/2012).
19 See: B. van Abel – L. Evers – R. Klaassen – P. Troxler (eds.), *Open Design Now. Why Design cannot Remain Exclusive*, BIS Publishers, Amsterdam 2011, Visual Index 207-213.
20 http://www.dezeen.com/2009/09/08/food-probe-by-philips-design/ (27/5/2012).
21 http://blog.makezine.com/2010/01/13/mits-food-printer/ (27/5/2012).
22 http://creativemachines.cornell.edu/node/194



2.16:
Shapeways: on-line 3D fabrication service (21/5/2012).

2.19:
Tests of printing food in 3D at Cornell University.





2.20:
A MakerBot printing out chocolate: 3D printing food project by the Spanish architect José Ramon Tramoyeres of GGlab at Domus exhibition "The Future in the Making", Salone del Mobile 2012.

2.17:
Food printer concept by Philips Design.

2.18:
"Cornucopia" concept by MIT's Fluid Interfaces Group.

The Cornell researchers report that 3D printing — or what they call "Solid Freeform Fabrication" (SFF) — may "make its mark on the culinary realm by transforming the way we produce and experience food. Food-SFF would benefit the professional culinary domain primarily in two respects: by lending new artistic capabilities to the fine dining domain, and also by extending mass-customization capabilities to the industrial culinary sector."

Food 3D printing is currently a hot topic and not confined to research laboratories: at Domus exhibition "The Future in the Making" at Palazzo Clerici during the Salone del Mobile in April 2012 in Milan, a project by the Spanish architect José Ramon Tramoyeres of GGlab showed how 3D printing technology could been applied to gastronomy and haute cuisine in a research that combined cookery, design, food, and aesthetic.[23]

There are also projects situated in the art domain dealing with food printing, like the project by Mischer'Traxler "Till you stop"[24]: a cake decoration machine that allows the visitor to decide how much decoration is applied onto their cake. The machine decorates the cake with lines similar to a spirograph until the visitor decides to stop the decoration process.

Printing machines for printing any 2D image directly on cakes, pastries, and chocolate with water-based food-grade ink also exist.[25]

The domain of "Food Design" is a relevant topic. There are chefs and restaurants that make experiments in that field. This is a very broad subject, yet it will not be discussed here because it would go beyond the scope of this project.

2.2.5 3D Scanners

One way to create models suitable for 3D printing is to use dedicated software for 3D modeling.[26] Until few time ago the use of this kind of software was reserved to the professional sector, since the costs were high and the learning curve steep. Now more and

(27/5/2012), http://www.smartplanet.com/blog/business-brains/3d-food-8216printing-coming-to-a-kitchen-near-you/12548 (27/5/2012).

23 http://www.domusweb.it/en/video2/jose-ramon-tramoyeres-domus-design-archipelago/ (4/6/2012), http://www.foodinprogress.com/food-printing-al-salone-del-mobile/ (4/6/2012).

24 See: http://www.mischertraxler.com/projects_till_you_stop_cake_decoration.html (27/5/2012); R. Klanten – S. Ehmann – V. Hanschke (eds.), *A Touch of Code. Interactive Installations and Experiences*, Gestalten, Berlin 2011, pp.140-141.

25 For example: http://www.masterpiece-systems.com/#nolink (29/5/2012), http://www.chocolography.com/home.php (27/5/2012). Other more traditional methods for transferring 2D designs on chocolate are transfer sheets, hand screening and stamping, see for example: http://www.americanchocolatedesigns.com/transfer_sheets.php (27/5/2012).

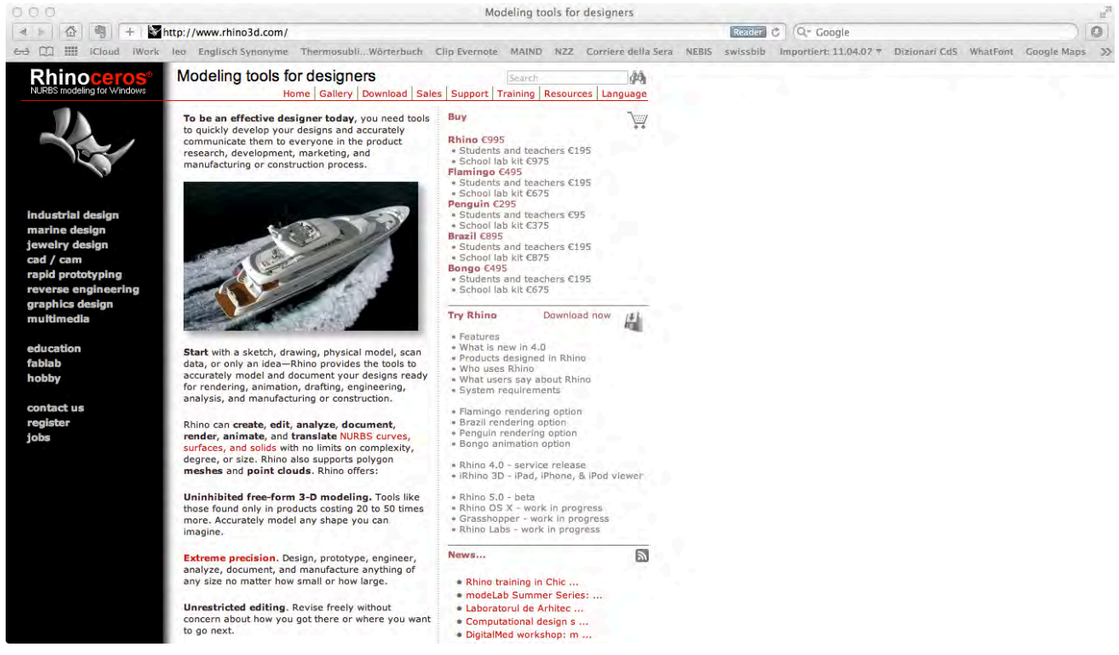
26 For example Rhinoceros: http://www.rhino3d.com/ (15/6/2012).

2.21:
Art project "Till you stop" by Mischer'Traxler.

2.22:
Printing system MX-315, MasterPiece Systems Co.LTD, for printing 2D images directly on chocolate.

2.25:
Professional laser scanner by FARO.

2.26:
Windows Kinect for Xbox 360.



2.23:
Rhinoceros homepage, professional software for 3D modeling (15/6/2012).

more software for 3D modeling is free, open source and also targeted to non-professional users.[27]

Another way to create models for 3D printing is given by scanning existing objects. Again, until few time ago 3D scanners were very expensive devices used only in specific professional sectors.

There are different 3D scanning methods now available at reasonable costs,[28] but one big game changer was the introduction of the Microsoft Kinect, a device that has a depth camera that uses infrared light for recording also the positioning in space of the objects that are placed in front of it.[29] Originally intended to work only with the Xbox 360 gaming console, only few days after its launch onto the market in November 2010 it was "hacked", and programmers around the world began working on open source drivers that would let anyone access the data from the Kinect. This led to an explosion of libraries that made the Kinect accessible in a variety of environments. In the meantime Microsoft sells also a special Kinect for Windows with a dedicated software development kit (SDK) for commercial applications,[30] and Asus produces a similar device called Xtion PRO.[31]

Suddenly a technology once reserved to specialized sectors was being available at a cost of around 100 € and a whole community of hackers, scientists, designers and artists recognized its potential for manifold uses.[32] What interests here is that there is now free open software available that makes it reasonably easy to transform the Kinect into a powerful 3D scanner.[33]

2.3 Insights

This quick overview of devices and services related to "scanning" and "printing" in a wide sense and with a special attention on methods related to 3D allows some important insights.

27 For example Google SketchUp: http://sketchup.google.com/ (20/5/2012). Autodesk has a whole range of applications for making 3D modeling more easy and mainstream: Autodesk 123D, http://www.123dapp.com/ (14/5/2012).

28 An up to date overwiev is given in: D. Bachfeld - P. König – V. Zota, *Kopieren in 3D. Räumlich scannen mit Digitalkamera, Kinect oder Laser-Scanner*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 86–91.

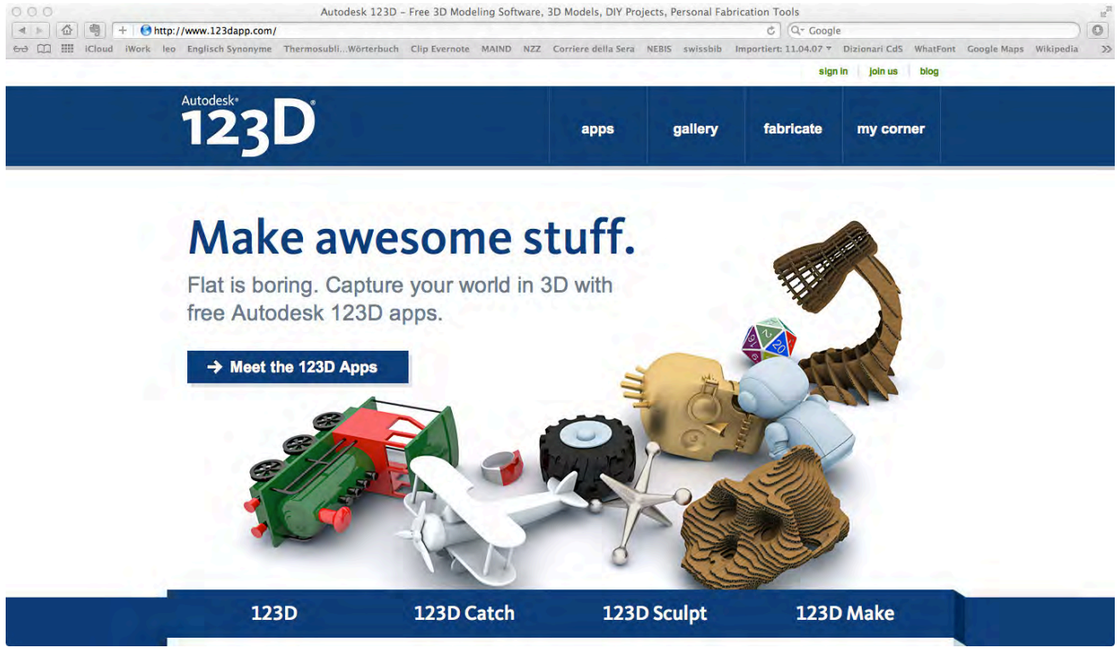
29 A detailed description of the Kinect and insights of its potential are given in: G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012.

30 http://www.microsoft.com/en-us/kinectforwindows/ (18/5/2012).

31 http://www.asus.com/Multimedia/Motion_Sensor/Xtion_PRO/ (18/5/2012).

32 For example see the growing collection of projects on: http://www.kinecthacks.com/ (18/5/2012).

33 A detailed tutorial is given in: G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012, pp. 301-344. The software for Windows called ReconstructMe is free for non commercial usages and is very powerful for creating good models for 3D printing with the Kinect: http://reconstructme.net/ (15/5/1012).



2.24:
Autodesk 123D applications homepage (21/5/2012).

2.27:
Homepage of Instagram (21/5/2012).

2.28:
Instaprint printers.

Technologies that just few time ago where very expensive and barely usable by non-professionals, are becoming more accessible, this thanks to a never seen before availability of technology at low prices and also to the contributions of the "open" movement.

Digital photo cameras are a widely diffused commodity nowadays: almost every mobile phone comes with a camera. It is also relevant to point out that analogue techniques are still popular and do fulfill manifest needs. There are also some interesting projects encompassing the digital and the analogue worlds and introduce social interactions to taking photographs and printing them out. For example the popular application Instagram adds social components to taking photographs with mobile phones[34] and the related device Instaprint provides a physical printer for the pictures taken with Instagram.[35] Those projects show that there is a high demand for interacting via taking pictures and printing them out and that there is also a need for the physical, tangible element as well as for personalization.

Other important insights are that the digital workflow common in the 2D world can be newly applied to physical objects: 3D scanning and 3D printing are moving from the professional sector to the mainstream. For example, thanks to the Kinect, a powerful 3D scanner is now widely available at a low price.

Last but not least, research on 3D printing showed that interesting uses in that domain like food printing are beginning to leave the secrecy of the research laboratories and showing great potential for the near future.

34 http://instagr.am/ (20/05/12).
35 http://instaprint.me/ (20/05/12).

3 Scenario Design and Concept Generation

3.1 Context/Domain Analysis and Opportunity Areas

The last chapter provided an overview of different devices and services related to "scanning" and "printing" in a wide sense. From this outline some significant insights were filtered out. Particularly relevant insights for the aim of the project are that: taking pictures and printing them out is seen as an important way for interacting with each other, that there are interesting projects showing the appeal of encompassing the digital and the analogue world, and that in our digital dominated era there is a manifest need for physical, tangible elements as well as for personalization and uniqueness.

It was also shown that technologies related to photographing, scanning and printing are experiencing a never seen before availability and popularity, thanks to a wide accessibility of high level technology at low prices and also to the contributions of movements that share software and hardware with open licenses, often for free.

Research on 3D printing proved that many interesting uses are surfacing and showing a great potential in that domain, a particular interesting one being food printing.

This analysis led to envisage the following opportunity area: a service for creating customized, printed edible objects, taking advantage of the widespread availability of technologies for photographing and scanning, and the clear willingness of users to use these technologies as interaction tools. At the same time this service is fulfilling the need for exchanging information in a tangible, personal and unique way.

The service is intended to allow users to take a traditional 2D picture or a 3D scan of an object of their choice, to load it on-line to the service (via a dedicated website or application) that will then provide one ore more prints of the subject in an edible format. The users can have the opportunity to choose between a set of options for the prints and for their delivery.

Also physical stores can be part of the service: special bakeries where customers can directly bring their pictures or 3D scans, or let high quality pictures or 3D scans be professionally taken, where they can be personally advised and where they can pick up the ordered edible printed products in person if whished.

It is important to point out that since the service relies on photographing and 3D scanning, the users are not simply choosing something from a predefined list: they are in control of the final result but do not have to "design" the product, something the majority of users usually do not want to do and are not able to do (even more if it is in 3D).

With this service the users have the possibility to communicate something in a very personal and unique way. The possibilities are endless; the edible product can be a simple reminder like "I am thinking of you", a gift, a message, a record, a shared memory, etc. It can be something very personal, poetic, something for a family member or for a beloved, but also something official, a marketing giveaway, etc.

The fact that the outcome is edible makes it sustainable: no waste and no objects that crowd the home of the recipient, no need for storage space and dust sweeping.

The fact that the recipient is supposed to eat the message enhances the taste (and to a grade also smell and touch) as a medium for exchanging messages, a sense that otherwise is usually neglected in this domain in favor of sight and hearing.

Eating and swallowing the message is a very strong experience because the recipient incorporates the message in his/her own body.

Another key element is that of transience, since once eaten the printed message is not physically there anymore: caducity is one of the factors that contributes to make analogue techniques like Polaroid fascinating.

3.2 Personas

The pictures of the personas where chosen among the pictures on the "Exactitudes" project website.[36]

36 http://www.exactitudes.com/ (1/7/2012).

Giovanna and Stefano, "new parents"

BACKGROUND
- Mid of their thirties
- Happy and proud new parents
- Both of them use computers and smartphones at work and at home, and are tech savvy
- Frequently buy on-line

GOALS
- Desire to communicate with their relatives and friends
- Like to communicate using the newest technologies
- Always look for creative and special services

OPPORTUNITY
- Offer a creative and special service to communicate with their relatives and friends using new technologies

Silvia, "businesswoman"

BACKGROUND
- Early forties
- Businesswoman
- Uses computers and smartphones at work and at home
- Likes to buy groceries at the local market

GOALS
- Always searching for new ideas to communicate with her clients
- Appreciates human contact and personal advice
- Delegates work because has time constraints

OPPORTUNITY
- Offer a service to communicate with her clients in an original way, providing personal advice and time saving in doing the work for her

Naoto, "traveller"

BACKGROUND
- Late twenties
- Likes to travel a lot
- Has his smartphone always with him
- Uses the applications of his smartphone for almost everything while travelling

GOALS
- Desires to communicate with his relatives and friends at home while travelling
- Likes to communicate using his smartphone
- Likes to impress his relatives and friends with special souvenirs

OPPORTUNITY
- Offer an application for his smartphone to sent special souvenirs to his relatives and friends while travelling

Luca, "sweetheart"

BACKGROUND
- Teenager
- Passionate gamer, owns several gaming consoles and a Kinect
- Frequently visits on-line forums
- Occasionally buys on-line

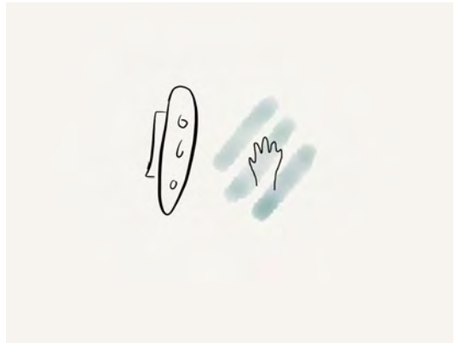
GOALS
- Desires to communicate with his friends
- Likes to communicate using the newest technologies
- Likes to impress his friends with special gifts

OPPORTUNITY
- Offer a special service to impress his friends using the technologies his peers and him use every day

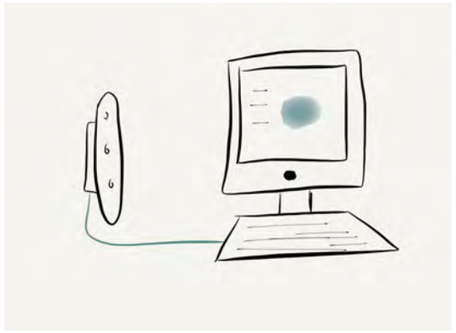
3.3 Storyboards

A Baby is Born

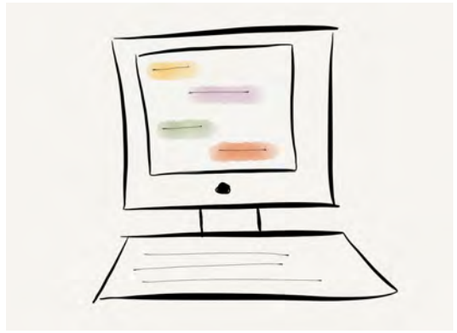
1. A baby is born. The parents Giovanna and Stefano want to send the news to relatives and friends.



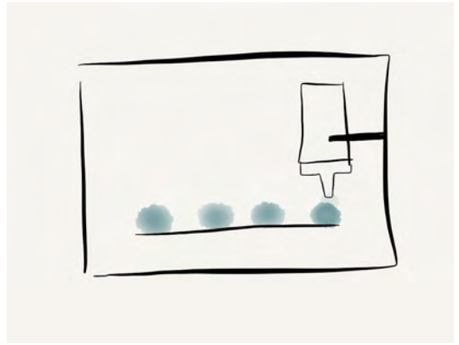
2. At home the parents take a 3D scan of the little hand of their newborn baby.



3. The parents upload the 3D scan to the website of the service.

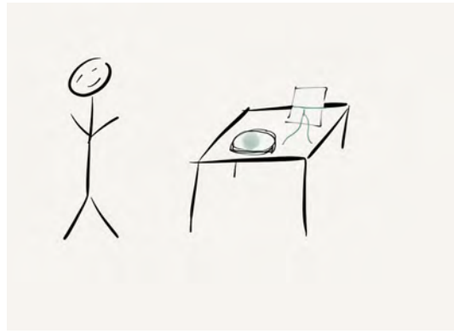


4. The parents choose the dough and the flavor, the packaging, the message, and they list all the addresses to where the 3D print has to be shipped.



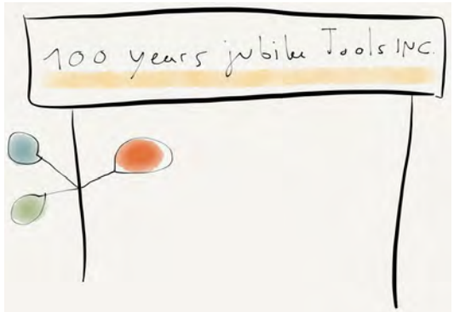
5. The service prints out the sweets in form of the little hand of the newborn baby.

6. The service sends out the little sweets to all the given addresses.



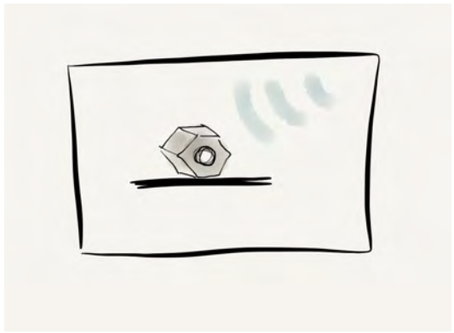
7. All relatives and friends receive the sweet news in form of a very unique and yummy message.

100 Years Jubilee

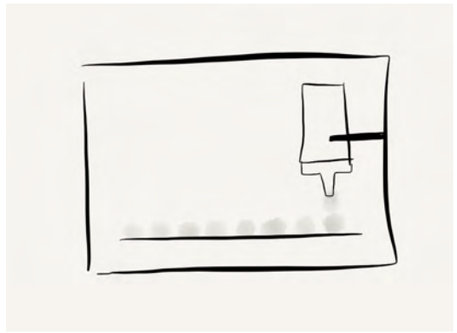


1. The company Tools INC. is celebrating a 100 years jubilee, and they want to communicate this achievement to their clients.

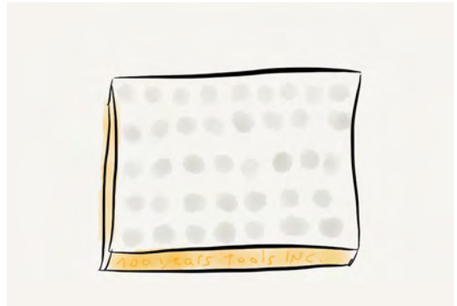
2. Silvia, the boss, decides to go to the bakery shop of the service to get a personal advice.



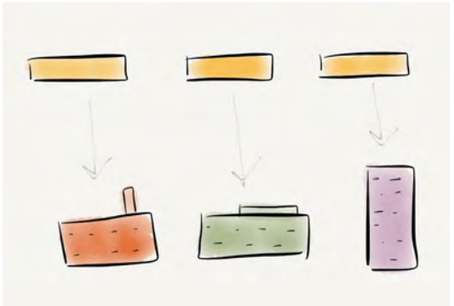
3. The chosen solution is to take a very high quality 3D scan in the shop of a bestseller of the company: the hexagonal bolt.



4. The hexagonal bolts are 3D printed in the shop in chocolate.



5. The chocolate hexagonal bolts are then packaged: 100 per box, as the number of the jubilee.



6. The service sends out the boxes to the clients of the company.

7. In the cafeterias of the clients of the company the employees enjoy the special marketing giveaway!

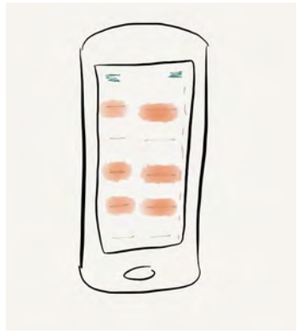
Souvenir from Paris

1. Naoto visits for the first time Paris and wants to send to his friends at home a special souvenir.

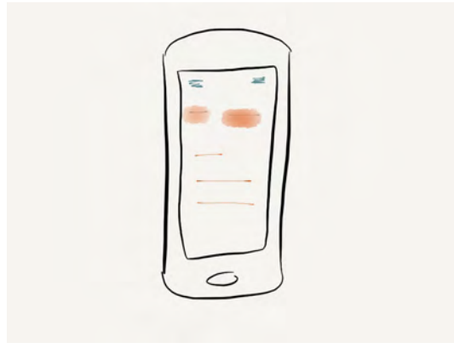
2. He takes a picture of the Tour Eiffel with his smartphone.

3. He uploads the picture to the application of the service.

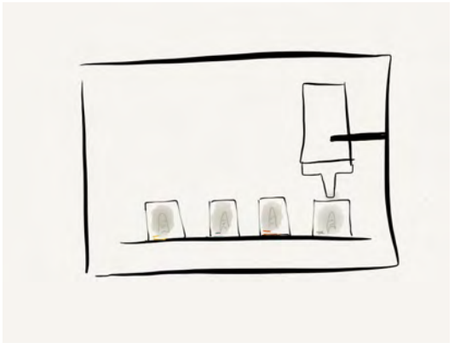
4. He chooses the option to print the picture on marzipan.



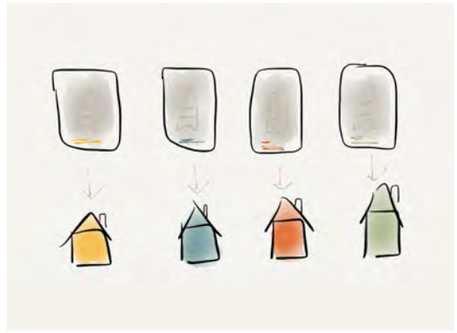
5. Using the contact list of his smartphone, he tells the service to whom he wants to send the special souvenirs.



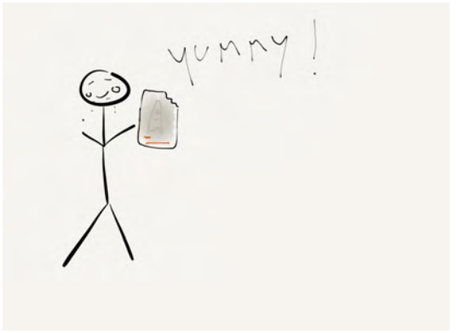
6. He makes use of the possibility to write a personal message for each address.



7. The service prints out the picture with the personalized messages on marzipan.



8. The service sends out the tasty souvenirs to the friends of Naoto at home.

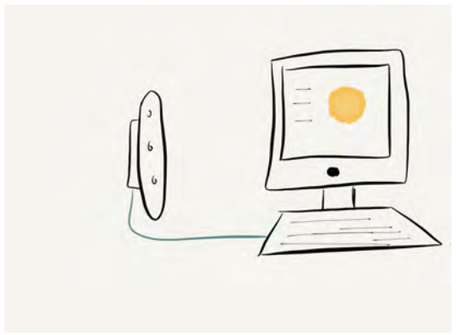


9. The friends of Naoto receive the special greetings from Paris!

Sweet Love

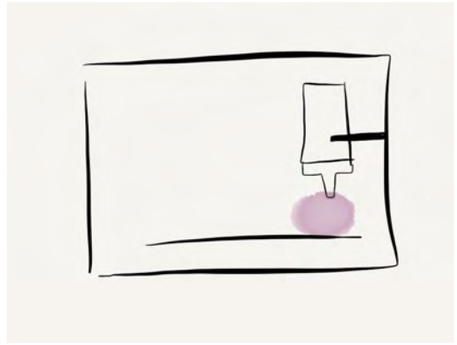
1. Luca sees the girl of his dreams every day on his way to school: she sits on a bench in the park wearing pink earphones.

2. Luca decides to impress her: back at home he takes a 3D scan of his earphones.

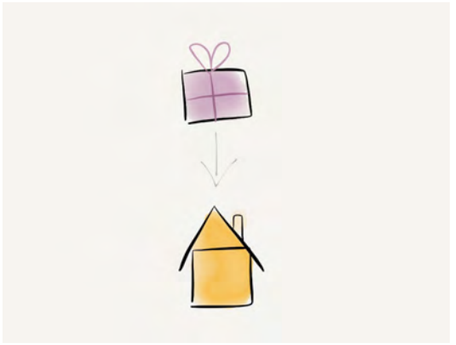


3. Luca uploads the 3D scan to the website of the service.

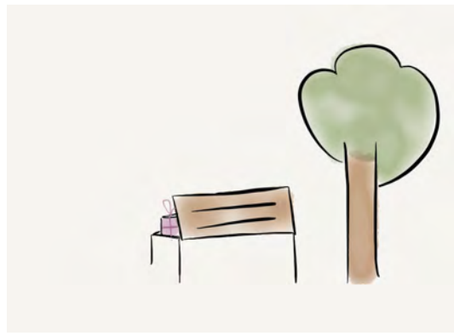
4. Luca chooses a pink color for the dough, strawberry as flavor, a sweet packaging and message, and gives his own address as the shipping destination.



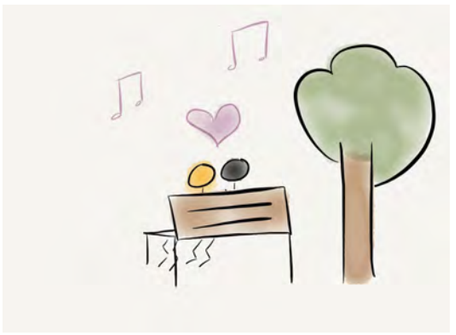
5. The service prints out the sweet pink strawberry earphones in real size.



6. The service sends out the sweet earphones to Luca's home address.



7. The morning after Luca goes out earlier and leaves the package on the bench where the girl seats every morning listening to music.



8. The following day Luca and the girl of his dreams are sitting together on the bench, talking about music, sweet pink strawberry earphones and many other things.

3.4 Framework Definition, Concept Generation

This section gives a list and short description of the different touchpoints needed for the service.

The service has a dedicated website where the users can upload their 3D scans or 2D pictures and choose between a set of options for the edible prints (scale, dough, flavor, color, absence of certain ingredients not suitable for certain categories of persons) and for their delivering (print quantities, packaging, personal messages and choice between shipping or picking up the products at a certain bakery).

The service will additionally have a dedicated application for iPhone in order to upload pictures to the service directly from the device while on the move. The application will have a selection of the options available on the website, adapted to the functions and capabilities of the mobile device.

The service also includes special bakeries where the users can personally deliver their scans or pictures and pick up the edible prints, be competently advised about all possible options and solutions and where 3D scans and pictures can be professionally taken with high resolution and optimized for the desired printing.

The service includes specialized factories where the main logistics of the service is taken care of and the on-line orders processed.

In the factories as well as in the bakeries there will be special food printers for printing out edible 2D or 3D objects with different doughs, flavors, and colors.

3.5 Detailed Concept for Prototyping

The service is prototyped on different levels. The aim is to illustrate the technological feasibility as well as the user interaction with specific working prototypes.

A user evaluation test based on interviews contributes to the decision of which parts are to be especially developed.

The following parts of the service are going to be prototyped:

- 3D scanning (based on Microsoft Kinect);
- 3D printing (simulated printing ABS thermoplastic);
- structure, design and selected wireframes of the dedicated website;
- design and selected screens of the dedicated application for iPhone.

The bakeries and the factories, that are part of the service, will not be discussed in detail and are not the subject of prototypes.

4 Project Development

4.1 User Evaluation Test

The user evaluation test implies face-to-face interviews with potential users of the service. The aim is to let the interviewed persons speak as freely as possible, without giving them the impression of being guided, asking rather open questions that will encourage them to speak fluently for themselves, in order to gain as many genuine information as possible about the service in general, the parts that are more likely to be used, the improvements that can be made, the needs of the users, etc. The numbers of things they discuss and propose are used as indicators of the grade of interest for the service. The insights of the interviews are used as inspiration for further development and fine-tuning of the service.

Giving those objectives and considering the time constraints, four people whose characteristics correlate with the one of the four personas (see chapter 3.2) were interviewed.[37]

At the beginning of each interview, the four storyboards (see chapter 3.3) were presented and quickly explained to the interviewed, potential open questions from his side were answered.

The following series of questions were asked:

1. Which is your favorite storyboard? Why?
2. For what purposes would you use the service? What would you scan? For what occasions? For which people?
3. Which options are important for you, or you would like to have or you would miss (for example: scanning options, options for choosing the flavor, the dough, the messages, the packaging, etc.)?

The results of the interviews were summarized for each interviewed person and an overview of the insights is provided. Results and insights are used to support the definition of the functionalities and the user experience of the service, to fine-tune the prototype and to decide which parts are to be especially developed for the final prototype.

Matteo and Simona, "parents of two young children", 36 and 35

1. Their favorite storyboard was "Souvenir from Paris", because they use to carry the iPhone always with them and they like the idea to be able to do many different things with their phone, easily and on the move. They found the story "A Baby is Born" a bit macabre and suggested to scan either an imprint of the hand or feet of the baby, or to scan the baby's shoes.
2. They would use the service for different occasions, for example:
   - as gifts or giveaways at children birthday parties (adapted on the theme of the party or on the season of the birthday);
   - as a special "thank you message" for marriage gifts (for example a scan of a particular object or subject they found on the place where they went on honeymoon);
   - as a special "thank you message" for gifts (both are researchers and mentioned that for thanking for a book about sculpture in Petra they would send a miniature 3D print of a sculpture found in Petra).

37 For privacy reasons the names of the interviewed persons were changed.

4.1:
Storyboards and questionnaires used for the interviews.

3. In the options they would consider particular needs (vegetarians, people with diabetes, etc.); they found it important to be able to choose the right style for the packaging of the product (consider different categories, for example "classic", "pop", etc.).

Franco, "businessman", 62

1. His favorite storyboard was "100 Years Jubilee" because it was the one closest to his needs.
2. He would use the service especially for marketing purposes, for example:
   - at events of his industrial company (for example a 3D print of a motor he is selling as giveaway);
   - at wine tastings events for his wine making company (for example 3D scans of corks with the name of the company engraved).

He would also consider letting print some special souvenirs (he mentioned the venetian gondola).

3. He pointed out that the service should also consider to offer "house visits" for big clients (he would not go personally to a bakery but would expect that an expert comes to his company to give personal advice).

Giulia, "traveller", 29

1. Her favorite storyboards were "Souvenir from Paris" and "100 Years Jubilee": she liked that there are different possibilities, either "do it yourself" or having the human personal advice if wished.
2. She would use the service for different purposes, for example:
   - 2D scans with the iPhone for surprising friends and family with fancy gifts;
   - 3D scans for "professional" purposes (would prefer to visit a bakery and not do the scan at home).
3. Regarding the options, she found the packaging very important and she proposed also to consider carefully the inner of the packaging, as well as the possibility to choose the flavor (that should not necessarily be sweet) and the color of the print.

Sara, "sweetheart", 33

1. Her favorite storyboard were "Sweet Love" and "A Baby is Born", she found them very cute and original ways to communicate something special to someone special.
2. She felt that she would use the service just for special occasions, not for common events. She would rather use the phone or go to the bakery instead of doing the 3D scan at home.
3. She underlined that she would like that it was made clear at first sight that the prints are edible and that the ingredients are natural and healthy. She felt that the flavors can be different but should all be sweet.

General insights

Considering the numbers of things the interviewed discussed and proposed and the large amount of time they dedicated to answer the questions, they can be considered as indicators for a high grade of interest and excitement for the service.

It is convenient that there are different ways to use the service: the single interviewed had very different requirements and preferences regarding the way of using the service, some liked more the "do it yourself" approach and others would rather seek for personal advice and not do the scans themselves.

In general 2D or 3D prints were considered at the same level and both attractive, not felt as having an influence on the relevance of the message.

Health concerns were often discussed, users cared that the ingredients have to be healthy and that it is clearly declared if they are suitable for certain categories of persons.

The "transitory" aspect of the service, the fact that the prints are eaten and then they are gone, was felt as an interesting and positive aspect of the service, which contributes to make it special.

4.2 Prototypes

4.2.1 3D Scanning and Processing of the Scans

For the first prototype of 3D scanning following hardware and software solutions were used:[38]

- Hardware: Microsoft Kinect for Xbox 360,[39] MacBook Pro 2011;
- Software: Processing 1.5.1,[40] OpenNI,[41] MeshLab 1.3.0.[42]

First a Processing sketch was used to produce files suitable for 3D design (STL), i.e. a 3D mesh that corresponds to the surfaces that were in front of the Kinect at the time the scan was taken. To create a closed structure suitable for 3D printing the holes in the meshes created by the Kinect were filled setting a depth value where the data were not available, creating a backplane.

Following libraries for Processing were used:

- OpenGL:[43] allows utilizing the speed of an OpenGL accelerated graphic card;
- Modelbuilder:[44] created by Marius Watz, provides tools that make it easier to create and manipulate 3D geometry in Processing and to export the resulting objects in a form that allows digital fabrication;
- SimpleOpenNI:[45] created by Max Rheiner, works with OpenNI for accessing the Kinect.

This is the Processing code used to create the STL file from the Kinect image:[46]

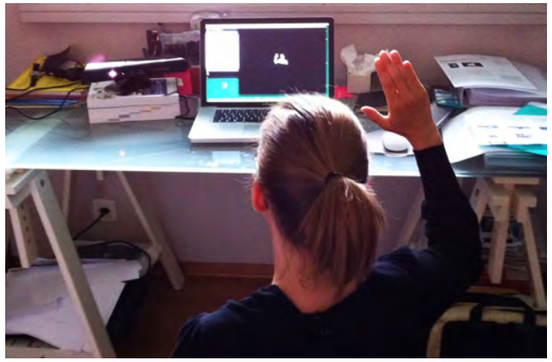
38 For a detailed description of the process see: G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012, pp. 301-344.
39 http://www.xbox.com/en-US/kinect/ (8/6/2012).
40 http://processing.org/ (8/6/2012).
41 http://www.openni.org/ (8/6/2012).
42 http://meshlab.sourceforge.net/ (8/6/2012).
43 http://processing.org/reference/libraries/opengl/index.html (8/6/2012).
44 http://code.google.com/p/codeandform/downloads/list (8/6/2012), http://workshop.evolutionzone.com/code/modelbuilder/javadoc/overview-summary.html (8/6/2012).
45 http://code.google.com/p/simple-openni/wiki/Installation (8/6/2012).
46 Taken from: G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012, pp. 325-327.

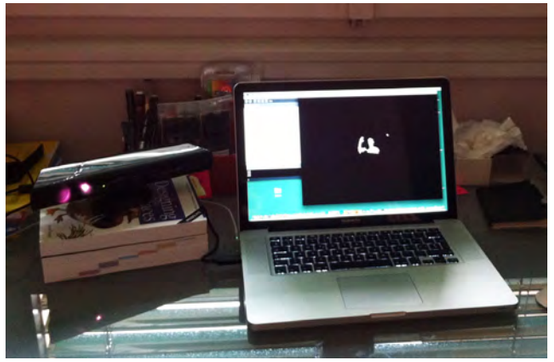
```
import processing.opengl.*;
import unlekker.util.*;
import unlekker.modelbuilder.*;
import SimpleOpenNI.*;
SimpleOpenNI kinect;

boolean scanning = false;
int maxZ = 2000;
int spacing = 3;

UGeometry model;
UVertexList vertexList;

void setup() {
    size(1024, 768, OPENGL);
    kinect = new SimpleOpenNI(this);
    kinect.enableDepth();
    model = new UGeometry();
    vertexList = new UVertexList();
}

void draw() {
    background(0);
    kinect.update();
    translate(width/2, height/2, -1000);
    rotateX(radians(180));
    if (scanning) {
        model.beginShape(TRIANGLES);
    }
    PVector[] depthPoints = kinect.depthMapRealWorld();
    for (int y = 0; y < 480; y+=spacing) {
        for (int x = 0; x < 640; x+= spacing) {
            int i = y * 640 + x;
            PVector p = depthPoints[i];
            if (p.z < 10 || p.z > maxZ
            || y == 0 || y == 480 - spacing
            || x == 0 || x == 640 - spacing)
            {
```

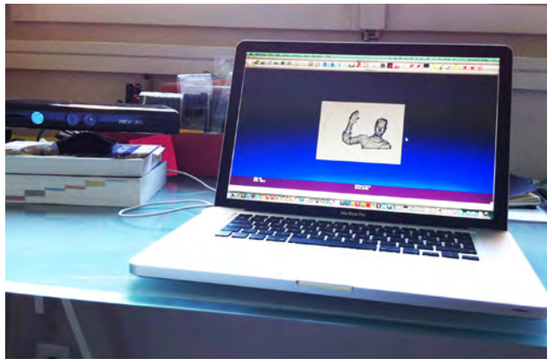


```
                PVector realWorld = new PVector();
                PVector projective = new PVector(x, y, maxZ);
                kinect.convertProjectiveToRealWorld(projective, realWorld);
                depthPoints[i] = realWorld;
            }
        }
    }

    for (int y = 0; y < 480 - spacing; y+=spacing) {
        for (int x = 0; x < 640 -spacing; x+= spacing) {
            if (scanning) {
                int nw = x + y * 640 ;
                int ne = (x + spacing) + y * 640;
                int sw = x + (y + spacing) * 640;
                int se = (x + spacing) + (y + spacing) * 640;
                    model.addFace(new UVec3(depthPoints[nw].x,
                    depthPoints[nw].y,
                    depthPoints[nw].z),
                    new UVec3(depthPoints[ne].x,
                    depthPoints[ne].y,
                    depthPoints[ne].z),
                    new UVec3(depthPoints[sw].x,
                    depthPoints[sw].y,
                    depthPoints[sw].z));
                    model.addFace(new UVec3(depthPoints[ne].x,
                    depthPoints[ne].y,
                    depthPoints[ne].z),
                    new UVec3(depthPoints[se].x,
                    depthPoints[se].y,
                    depthPoints[se].z ),
                    new UVec3(depthPoints[sw].x,
                    depthPoints[sw].y,
                    depthPoints[sw].z));
            }
            else {
                stroke(255);
                int i = y * 640 + x;
                PVector currentPoint = depthPoints[i];
```

```
                if (currentPoint.z < maxZ) {
                    point(currentPoint.x, currentPoint.y, currentPoint.z);
                }
            }
        }
    }
    if (scanning) {
        model.calcBounds();
        model.translate(0, 0, -maxZ);
        float modelWidth = (model.bb.max.x - model.bb.min.x);
        float modelHeight = (model.bb.max.y - model.bb.min.y);
        UGeometry backing = Primitive.box(modelWidth/2, modelHeight/2, 10);
        model.add(backing);
        model.scale(0.01);
        model.rotateY(radians(180));
        model.toOrigin();
        model.endShape();
        SimpleDateFormat logFileFmt =
        new SimpleDateFormat("'scan_'yyyyMMddHHmmss'.stl'");
        model.writeSTL(this, logFileFmt.format(new Date()));
        scanning = false;
    }
}

void keyPressed() {
    println(maxZ);
    if (keyCode == UP) {
        maxZ += 100;
    }
    if (keyCode == DOWN) {
        maxZ -= 100;
    }
    if (key == ' ') {
        scanning = true;
        model.reset();
    }
}
```



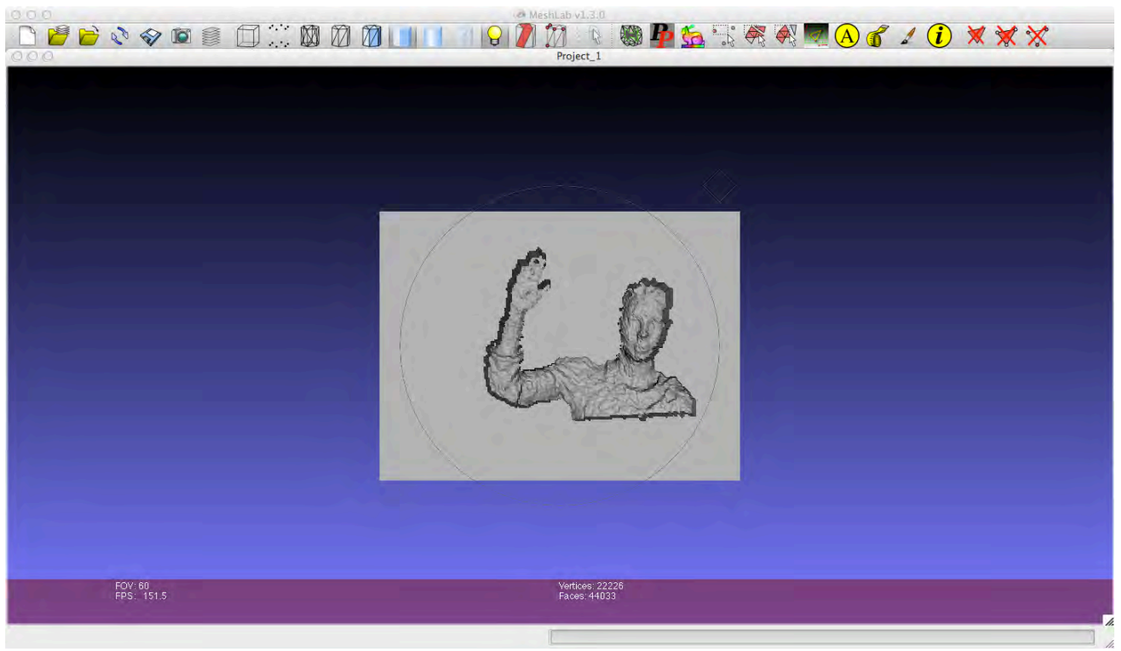


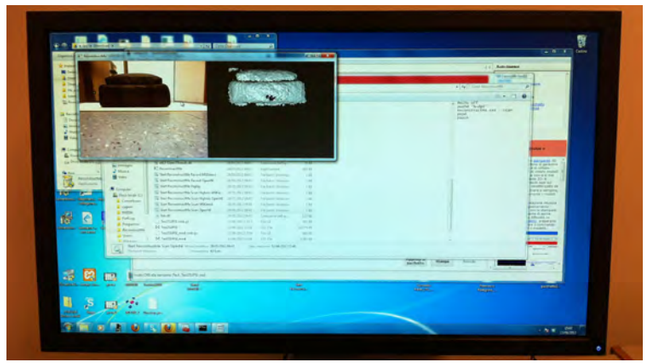
4.2:
Setup for the 3D scan with the author waving at the Kinect and the Processing sketch running.

4.3:
Close up of the 3D scan with the author waving at the Kinect and the Processing sketch running.

4.4:
Setup with the Kinect with scanned image for the prototype in MeshLab.

4.5:
Screenshot of the scanned image for the prototype in MeshLab.

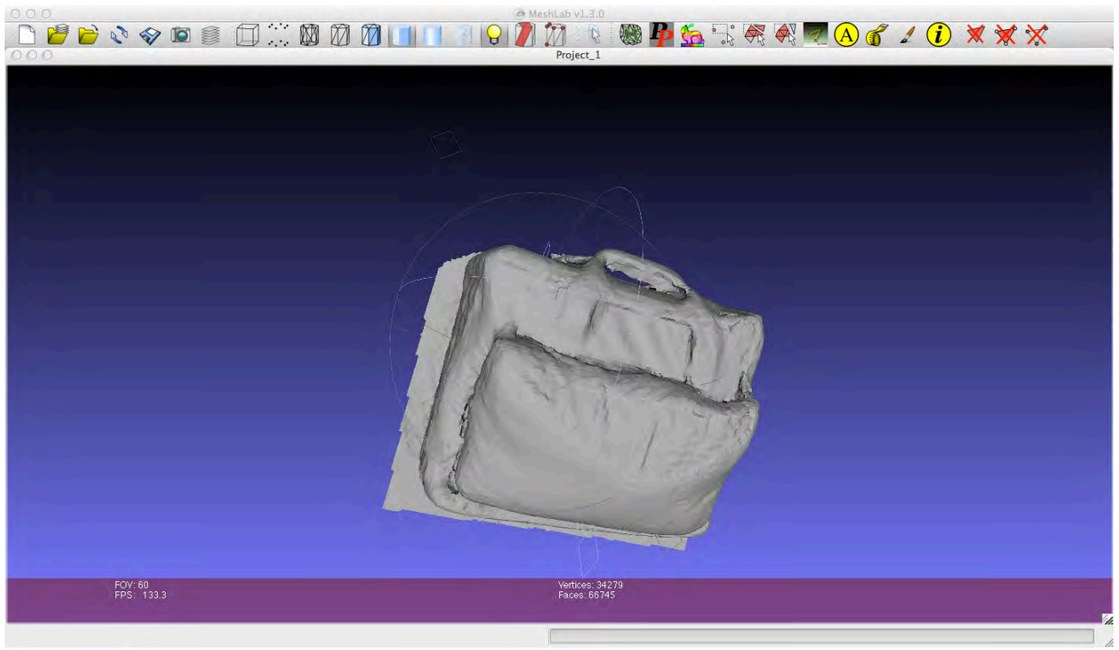


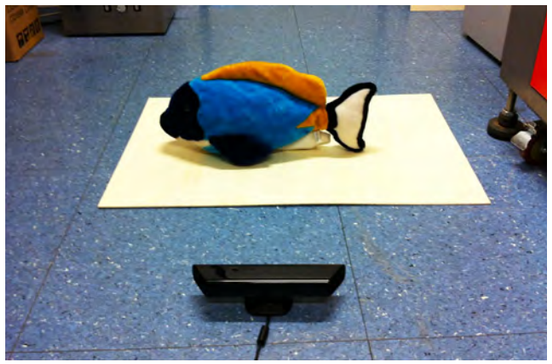


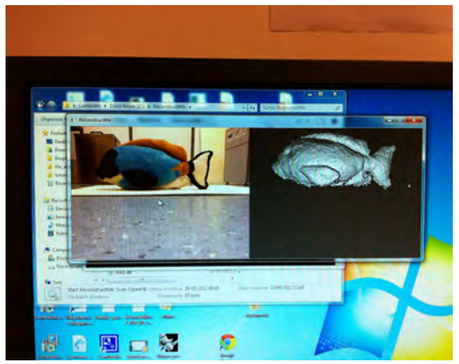
4.6:
Setup for the 3D scan with the Kinect and the bag.

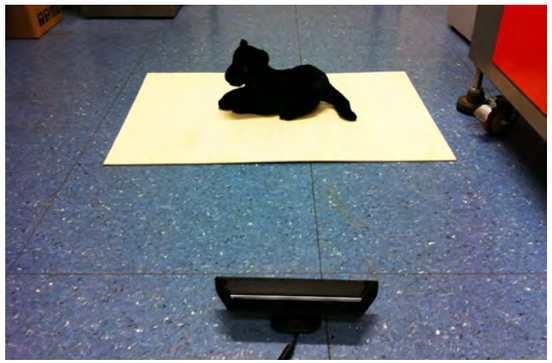
4.7:
Image of the desktop screen with the image from the Kinect and the 3D real-time scan in ReconstructMe.

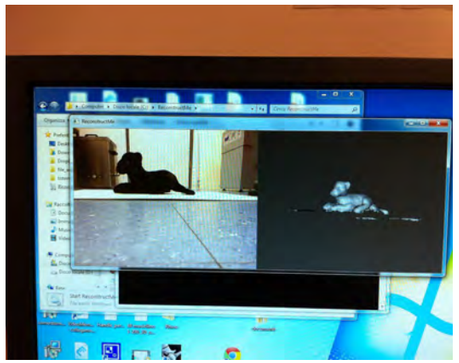
4.8:
Screenshot of the scanned image for the prototype in MeshLab.











4.9:
Setup for the 3D scan with the Kinect and a plush fish.

4.10:
Image of the desktop screen with the image from the Kinect and the 3D real-time scan in ReconstructMe.

4.11:
Setup for the 3D scan with the Kinect and a plush panther.

4.12:
Image of the desktop screen with the image from the Kinect and the 3D real-time scan in ReconstructMe.

This Processing code allows using the up and down arrow keys to adjust the z-threshold to better isolate the object to scan, and the space bar to save the result as STL file.

For the prototype, an image of the author waving at the Kinect was saved as STL file. After some tests a blanket was used in the background allowing an easier isolation of the image. The created STL file can be viewed and manipulated by external programs. For this prototype MeshLab was chosen, a powerful, free, cross-platform and open source software for viewing and processing 3D models. In this case MeshLab was used to simplify the meshes of the scan by reducing the numbers of polygons for creating a smaller SLT file for the 3D print.

For the second prototype of 3D scanning the following hardware and software solutions were used:

- Hardware: Microsoft Kinect for Xbox 360,[47] Dell Optiplex 780 desktop computer-[48]with an NVIDIA Quadro FX 580 graphic card;[49]
- Software: ReconstructMe,[50] OpenNI,[51] MeshLab 1.3.0.[52]

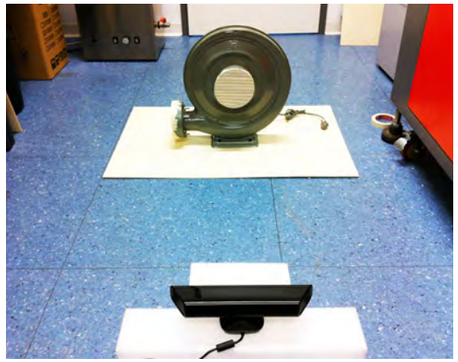
47 http://www.xbox.com/en-US/kinect/ (8/6/2012).
48 http://support.euro.dell.com/support/edocs/systems/op780/en/index.htm (13/6/2012).
49 http://www.nvidia.com/object/product_quadro_fx_580_us.html (15/6/2012).
50 http://reconstructme.net/ (13/6/2012).
51 http://www.openni.org/ (8/6/2012).
52 http://meshlab.sourceforge.net/ (8/6/2012).

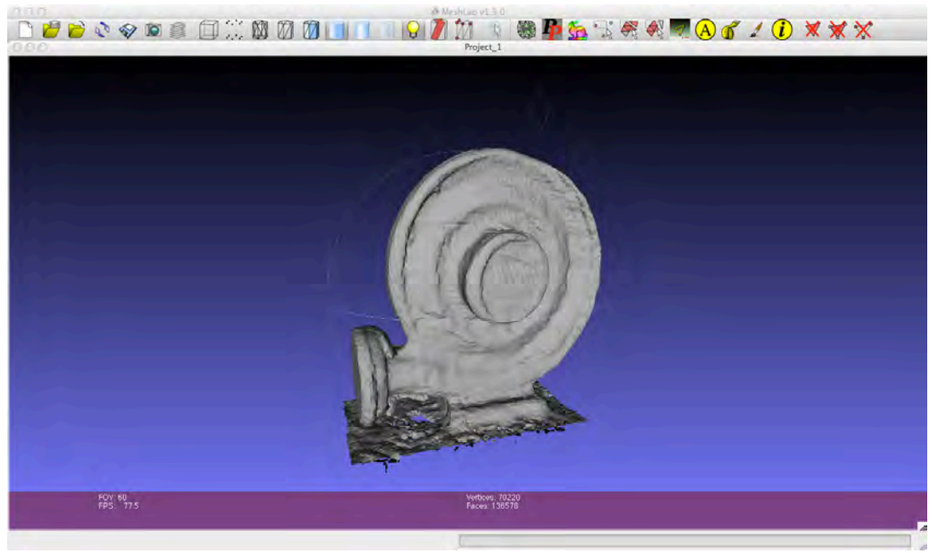
4.13-17:
Views of the centrifugal blower.

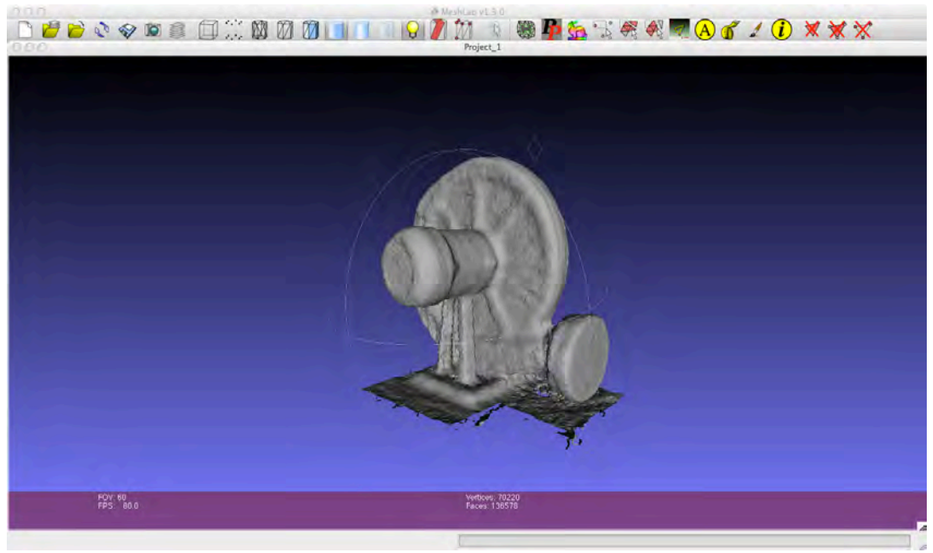
4.18-19:
Setup for the 3D scan with the Kinect and the centrifugal blower.

4.20:
Image of the desktop screen with the image from the Kinect and the 3D real-time scan in ReconstructMe.

4.21-22:
Screenshots of the scanned image for the prototype in MeshLab.







ReconstructMe is a powerful real-time 3D reconstruction system that is free for non-commercial use and supports different sensors. For the prototype, Microsoft Kinect for Xbox 360 was used. The standard resolution of ReconstructMe was used (for a higher resolution a more advanced graphic card would have been required).

For this second prototype a soft bag was 3D scanned first rotating the object in front of the Kinect and then at the end holding the Kinect by hand. The 3D model was then exported in the STL format suitable for 3D printing.

In this case the STL file was slightly cleaned up in MeshLab removing some parts that where taken by the sensor but were not part of the bag. The holes in the scan where not closed, and this had consequences for the 3D printing (see below).

For the third prototype the same hardware and software solutions as for the second prototype were used in order to experiment more with those techniques for achieving better results.

Tests were made using different objects, as for example plush animals.

At the end the following object was selected for being prepared for the 3D print: an iron centrifugal blower found in the FabLab.

The object was 3D scanned first by rotating several times the object in front of the Kinect and then holding the Kinect by hand. This time more attention was paid to close more holes in the meshes as possible while scanning. To facilitate the scanning some hollow parts of the objects where covered with tape.

The 3D model was then exported in the STL format suitable for 3D printing. Also in this case the STL file was slightly cleaned up in MeshLab, removing some parts that were taken by the sensor but were not part of the bag.

4.2.2 3D Printing

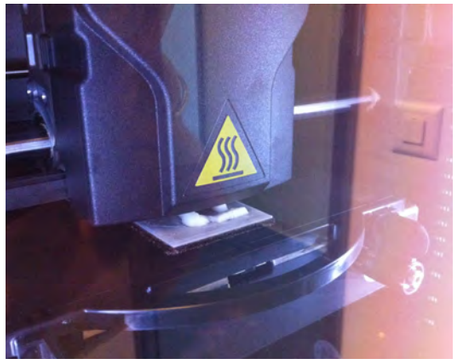
For the first prototype of the 3D printing following hardware and software solutions were used at the FabLab of SUPSI in Lugano:

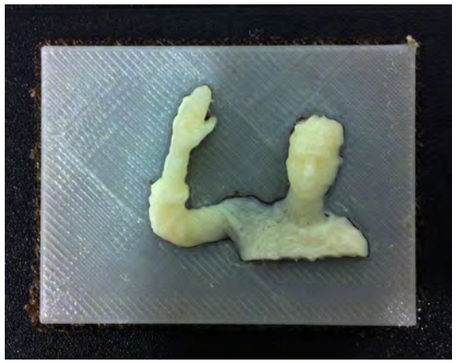
- Hardware: uPrint[53] by Dimension P51075, Dell Optiplex 780 desktop computer;[54]
- Software: CatalystEX.[55]

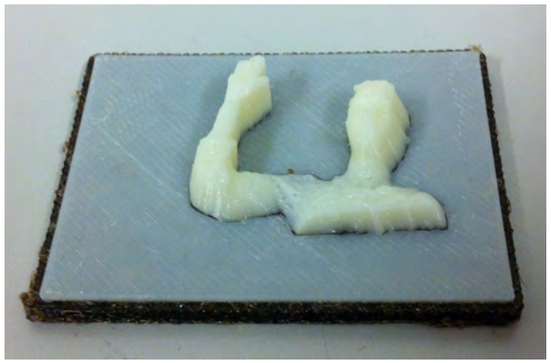
The STL file generated with the Kinect and Processing and modified in MeshLab was imported in the application CatalystEX and then adjusted for the printing with the 3D printer (small size and low resolution were chosen to save printing material).

Despite the small size and the low resolution the result of the first prototype was very satisfying, details like the fingers, the nose and the folds of the garment were recognizable. The decision was made not to remove the brown support material because it contributes to make the prototype resemble more an edible product, such as a biscuit with a couverture in low relief.

53 http://www.uprint3dprinting.com/ (8/6/2012).
54 http://support.euro.dell.com/support/edocs/systems/op780/en/index.htm (13/6/2012).
55 http://catalystex.software.informer.com/ (8/6/2012).







4.23:
uPrint 3D printer at the FabLab of SUPSI in Lugano.

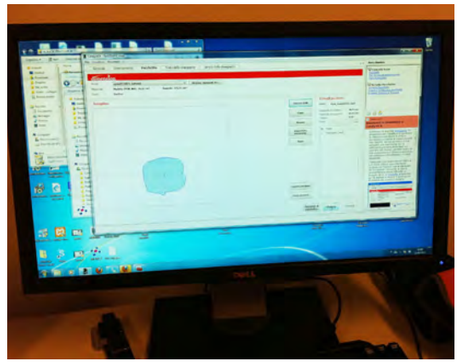
4.24:
Beginning phase of the 3D printing of the prototype (brown support material).

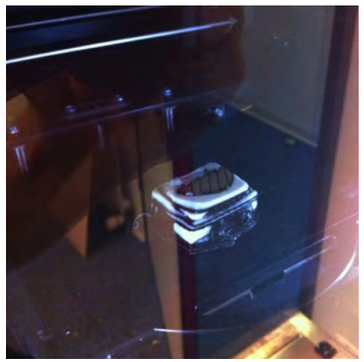
4.25:
Intermediate phase of the 3D printing of the prototype (the shape of the figure is recognizable).

4.26:
Advanced phase of the 3D printing of the prototype (the figure is already recognizable in relief).

4.27:
Finished result of the 3D printing of the prototype attached to the printing mount.

4.28:
Finished result of the 3D printing of the prototype with the brown support material in place.





4.29:
Image of the desktop screen with the prototype ready for printing placed in CatalystEX.

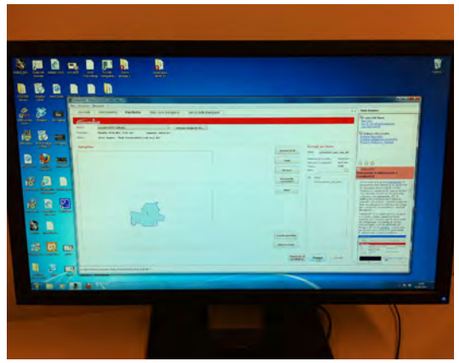
4.30:
Beginning phase of the 3D printing of the prototype with the first layers of the brown support material.

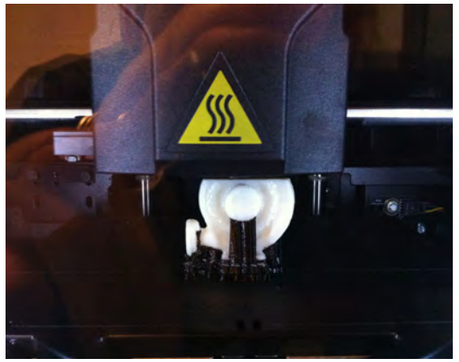
4.31:
Intermediate phase of the 3D printing of the prototype with different layers of brown support material and white ABS build material.

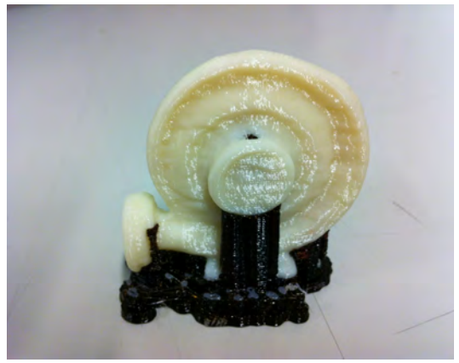
4.32:
Advanced phase of the 3D printing of the prototype with different layers of brown support material and white ABS build material.

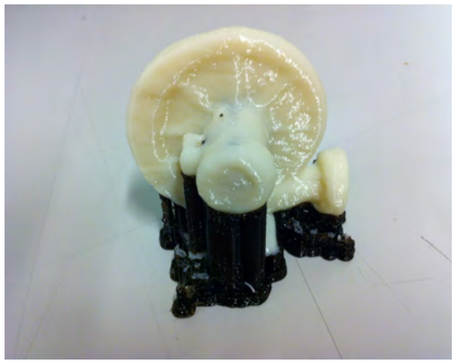
4.33:
Finished result of the 3D printing of the prototype attached to the printing mount.

4.34:
Finished result of the 3D printing of the prototype removed from the printing mount.









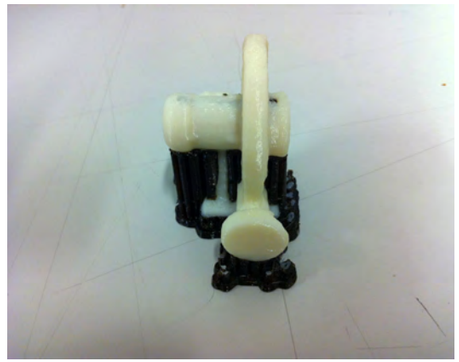
4.35:
Image of the desktop screen with the prototype ready for printing placed in CatalystEX.

4.36:
Beginning phase of the 3D printing of the prototype (support material and first layers of ABS build material printed).

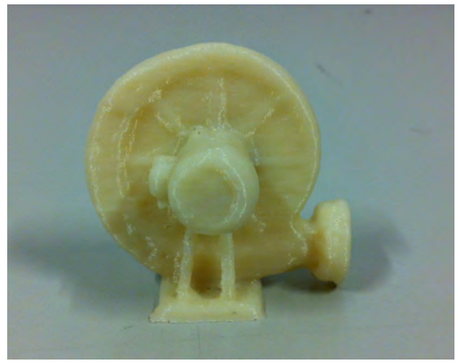
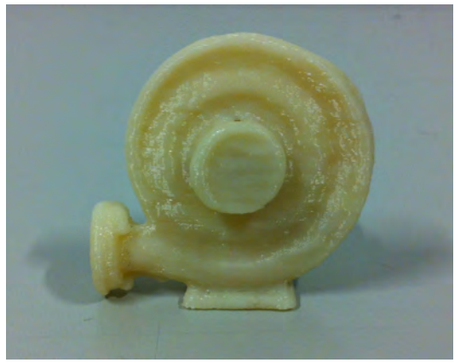
4.37:
Intermediate phase of the 3D printing of the prototype.

4.38:
Advanced phase of the 3D printing of the prototype.

4.39-40:
Views of finished result of the 3D printing of the prototype removed from the printing mount with the brown support material still in place.

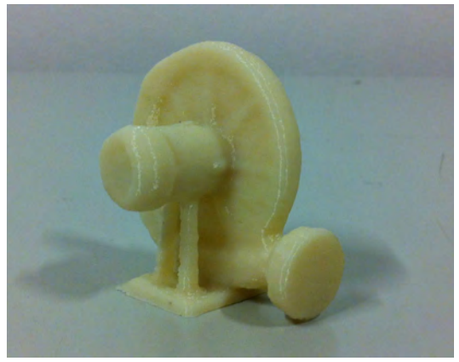
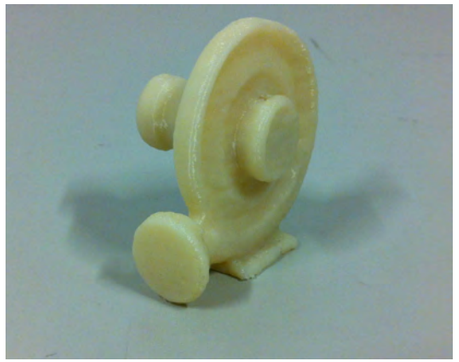
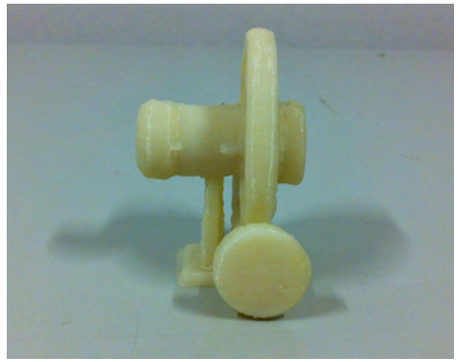
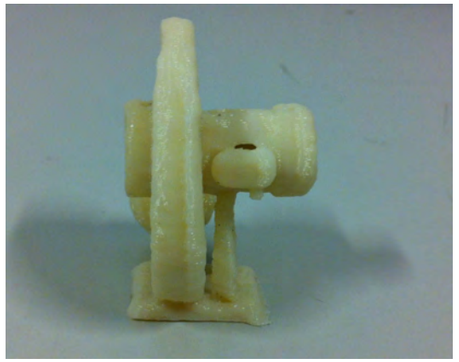
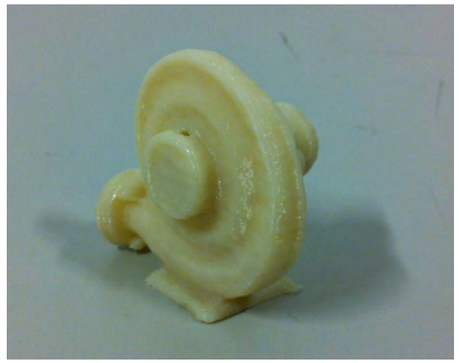
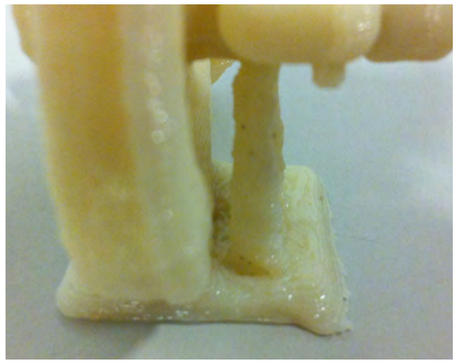




4.41-43:
Views of finished result of the 3D printing of the prototype removed from the printing mount with the brown support material still in place.

4.44-46:
wViews of the finished result of the 3D printing of the prototype.

4.47-51:
Views of the finished result of the 3D printing of the prototype.

4.52:
View of the finished result of the 3D printing of the prototype (detail).

For the second prototype of the 3D printing the same hardware and software solutions as for the first prototype were used at the FabLab of SUPSI in Lugano.

The STL file generated with the Kinect and ReconstructMe, then slightly "cleaned up" in MeshLab, was imported in the application CatalystEX and there adjusted for the printing with the 3D printer (small size and low resolution were chosen to save printing material).

As mentioned above the scan showed some holes in the surface of the meshes that where not filled in MeshLab. This had consequences for the 3D printing: CatalystEX filled the holes of the scan with the brown support material. The overall shape of the print did make the bag recognizable, but it was not all made with the white ABS built material. Despite this defects the prototype was documented because it shows very well how an edible print would look like when created out of two different doughs or kind of chocolate, with very interesting looking – and certainly also good tasting – layers and textures.

For the third prototype of the 3D printing the same hardware and software solutions as for the first and the second prototype were used.

Also in this case the STL file generated with the Kinect and ReconstructMe and "cleaned up" in MeshLab was imported in the application CatalystEX and there adjusted for the 3D printing (small size and low resolution were chosen to save printing material).

As mentioned above, in this case during the scanning process more carefulness was taken to close more holes as possible in the meshes. This improved the results: despite the small dimensions, the print resulted in a very detailed full 3D reproduction of the centrifugal blower in all of its parts, even the fact that two thin supports where detached from the rest of the object was recognized and printed out correctly.

The prototypes and tests described above show impressively that 3D scanning and printing is feasible with mass market available hardware and free software.

For the envisaged service, the "do it yourself" approach can work by offering on the website the software for download, indicating the hardware required for doing the 3D scans, and providing tutorials on how to use them to achieve the best results.

Another way can be to provide the customers with dedicated software and hardware specifically developed for the service. The software would have an easy to use interface and the Kinect-like sensor adapted to the use of home scanning.

Last but not least the service needs food printers tailored for these tasks.

4.2.3 Website

Site mission and goals

The website represents one of the main touchpoints of the service, where the user can get all the information about the service and is also able to place orders loading his 3D models and 2D images.

The goal of the site is to get as many users as possible to use the service, guiding them seamlessly through the steps necessary to purchase the final product (via the website or the other touchpoints of the service). The overall experience has to be very satisfying and enjoyable for the users, in order for them to become returning costumers.

Users' profile needs and tasks

The website is conceived to reach a broad range of users of different ages and backgrounds. The overall structure of the site is simple and as much self-explanatory and coherent as possible. The service in general and its functions are well and clearly explained, by words and by pictures and videos.

The site is built to satisfy the first time user as well as the returning customer. The first time user can retrieve all information on how the service works by explanations, tutorials and step-by-step guides. On the other side, the site satisfies the needs of experienced returning customers by allowing them to load and order the final product in a quick and easy way.

Site Map

See fig. 4.53, below.

Visual design

The overall design of the webpage is conceived with the service and the users in mind.[56] The layout is clean and tidy and allows a simple navigation with clear call to actions. The background is formed by an image of a paper that shows some slightly signs of usage: this evokes the "notes" part of the name of the service and contributes to give a "handmade" touch. The colors where chosen to compliment the "tasteful" part of the name of the service: pleasant colors like a light blue (R: 144, G: 164, B: 185) that harmonizes with the color of the paper (around R: 240, G: 236, B: 231), with a contrasting vibrant pink for the logo (R: 208, G: 87, B: 152). The font Courier New was chosen, since it underlines the "notes" character of the service, being a typeface designed to resemble the output of a traditional typewriter.[57] On the other hand it emphasizes also the "digital" aspect of the service, being Courier the font used in the 1990s in the electronic world in situations where columns of characters had to be consistently aligned, and Courier New being one of the core fonts for the web.[58] Common and widespread logos where used for referring to the social networks Facebook and Twitter and to the Apple App Store.

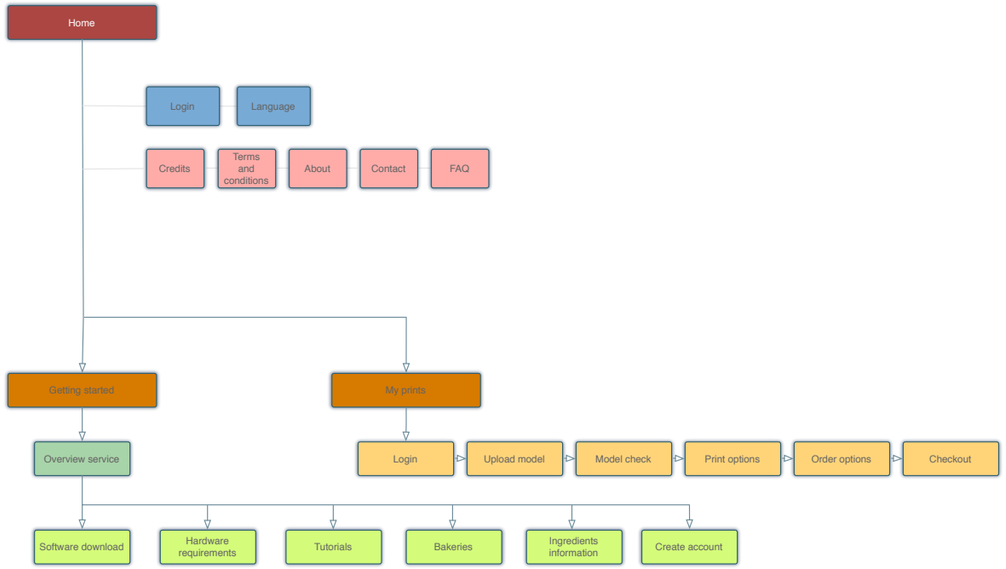
By describing the homepage, a general description of the website is given, since just one specific workflow will be prototyped using wireframes.

The home of the website (reachable from everywhere on the site by clicking on the logo) presents the two main entrance points for the two main categories of users: "Getting started" for the first time users, and "My prints" for the experienced returning

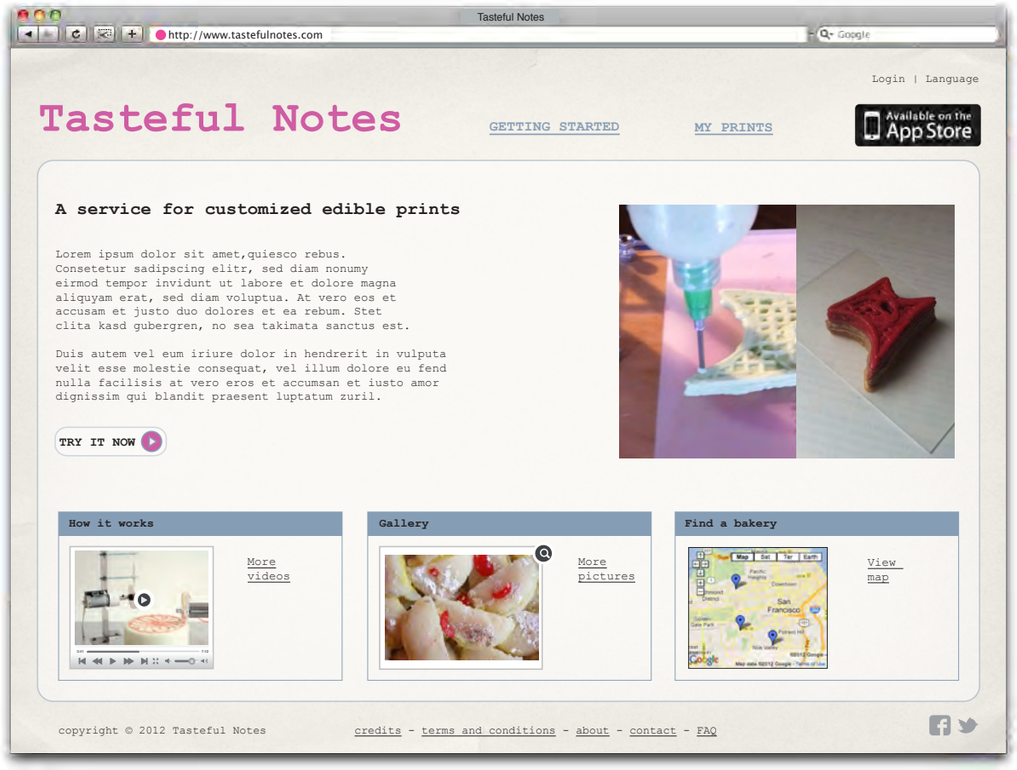
56 The prototype of the design of the home screen of the website was created using Adobe Illustrator.

57 http://en.wikipedia.org/wiki/Courier_(typeface) (4/7/2012).

58 http://en.wikipedia.org/wiki/Core_fonts_for_the_Web (4/7/2012).



4.53:
Site map.



4.54:
Homepage of the website.

customer. An icon serves as the direct link to the Apple App store to download the free iPhone application of the service. On the upper right corner, links redirect to the login and to the language selection: those sections appear on every page.

On the footer of the page, that is also present on every page, one can find the copyright notice and there are links to the following parts of the site: credits, terms and conditions, about, contact, and FAQ.

In the middle of the home page there is a general description of the service with a representative picture. Three boxes underneath allow to easy access several pages of the site. The "How it works" box redirects to the tutorials section with videos explaining the main parts of the service, how it works and how to use it; the "Gallery" box redirects to the overview of the service section with pictures of edible prints to inspire the customer and show what is possible to do; the "Find a bakery" box redirects to the section dedicated to the bakeries, that lists all specialized bakeries with a description of the service they offer and maps to easily locate them.

For the implementation of the website the newest web standards, HTML5 and CSS3 are to be used.

High-level overview of use-case "First time user"

The main entry point for the first time user of the service is the "Getting started" button located in the header (also the "Try it now" button on the homepage leads to that section). From there, the user can get an overview of the possibilities offered by the service, with different sections. One section is dedicated to the download of the software needed for creating the models, another one to learn what hardware is required for creating the models, a different section has many tutorials on how to best create the models (scans and pictures), and how to upload the 3D and 2D models to the service and order them (the different options are also explained and illustrated). Another section is dedicated to the bakeries, one contains precise indications about the ingredients used for the edible prints and the options offered to meet special requirements (vegetarians, specific food allergies, diabetics), and a section is for creating a personal account for the service.

A use-case of an expert customer is prototyped in the following chapter.

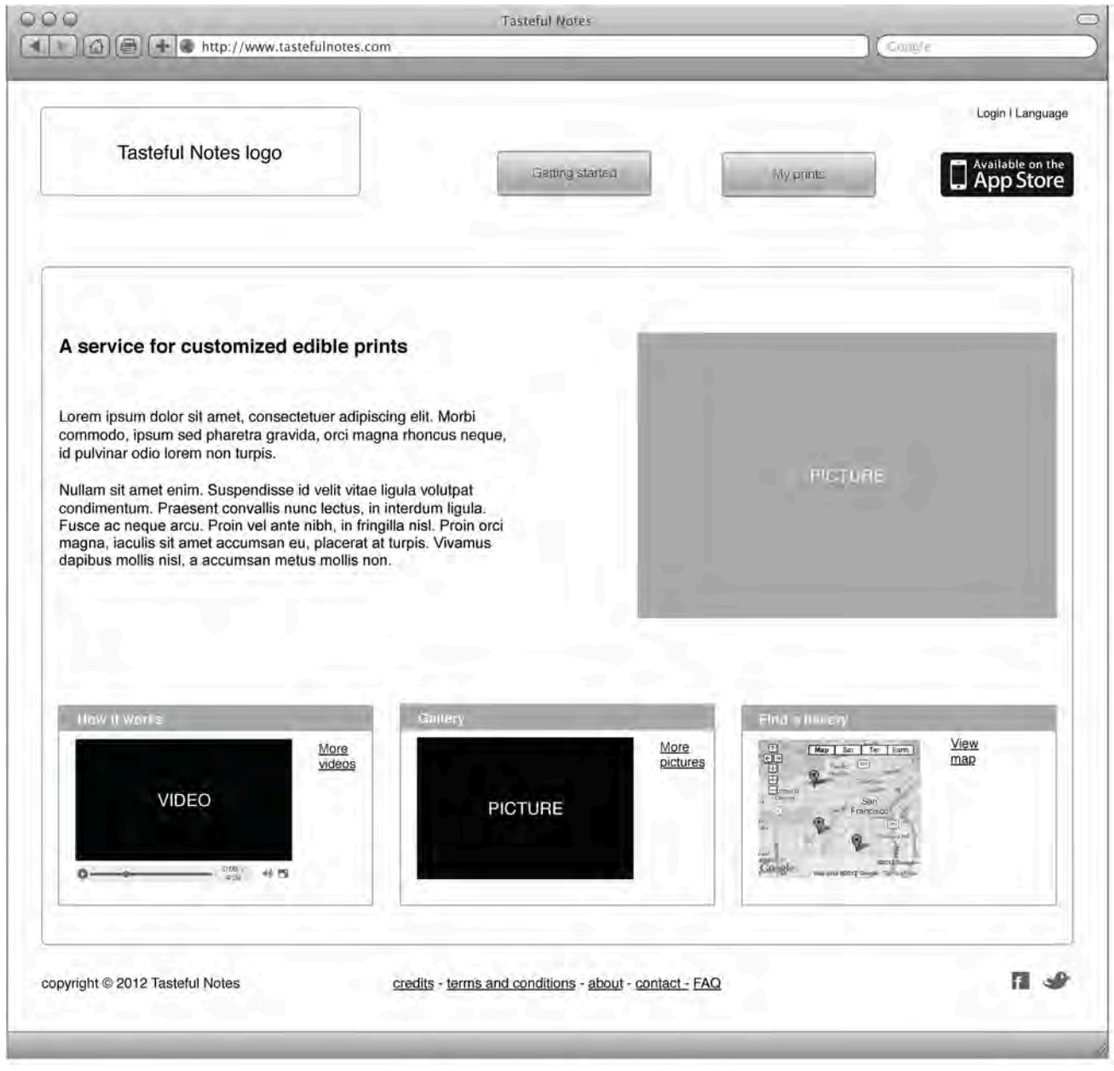
Selected workflow

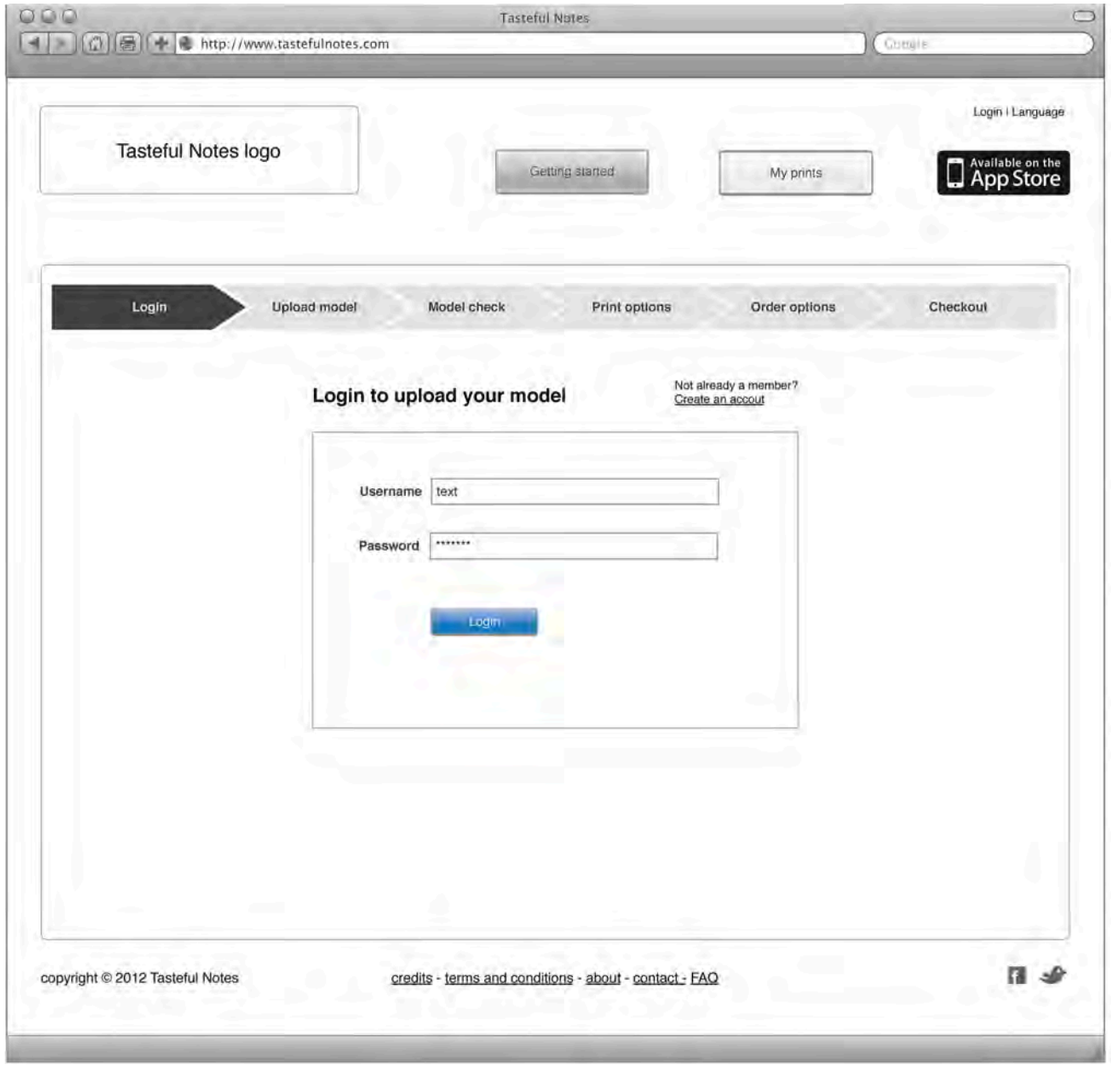
One workflow was chosen to be prototyped using wireframes:[59] the use-case of the expert, returning customer, that has already scanned his object and wants to upload it to the service and order quickly his print choosing some options (the entry point is the "My prints" button located in the header). The check-out procedure is not part of the prototype.

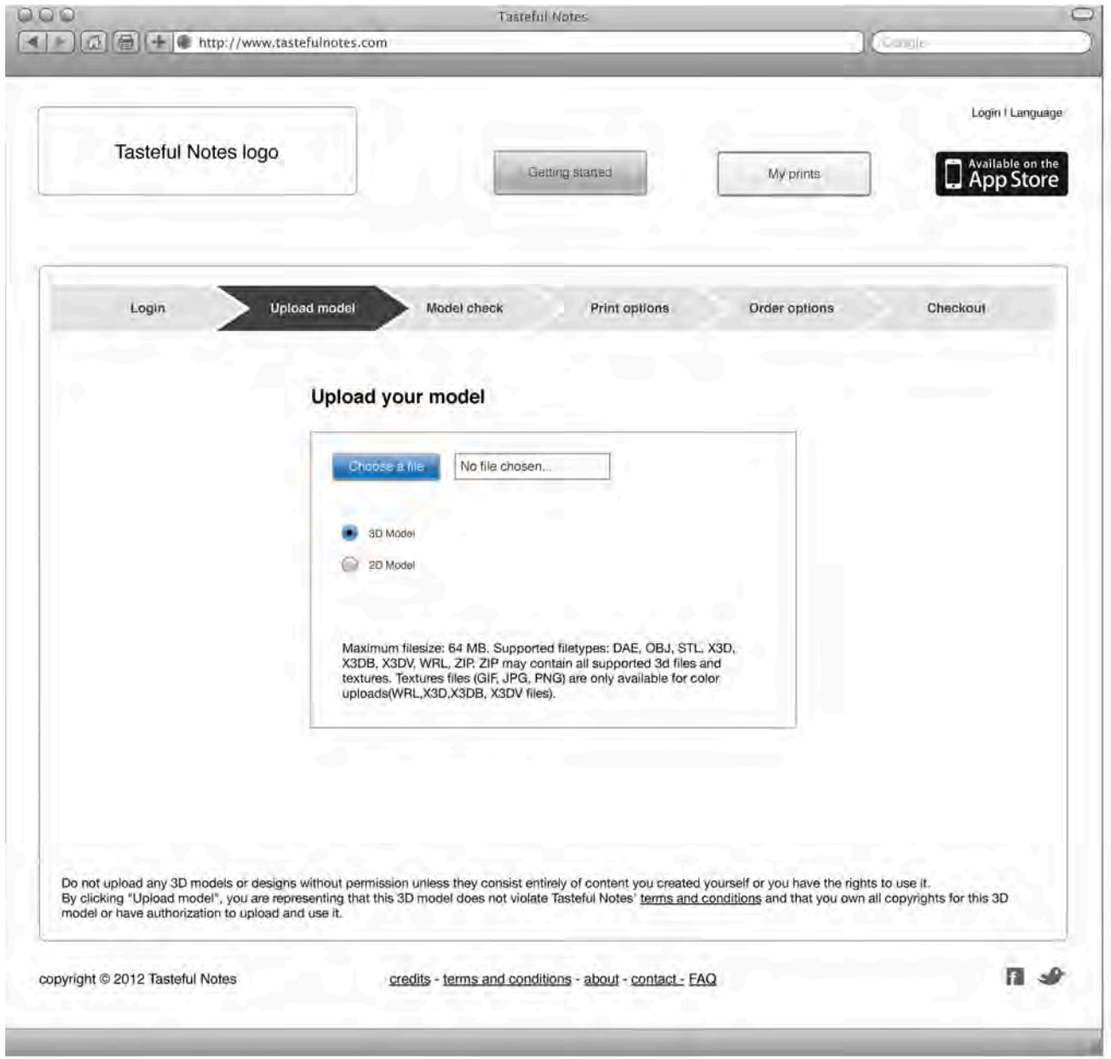
Wireframes

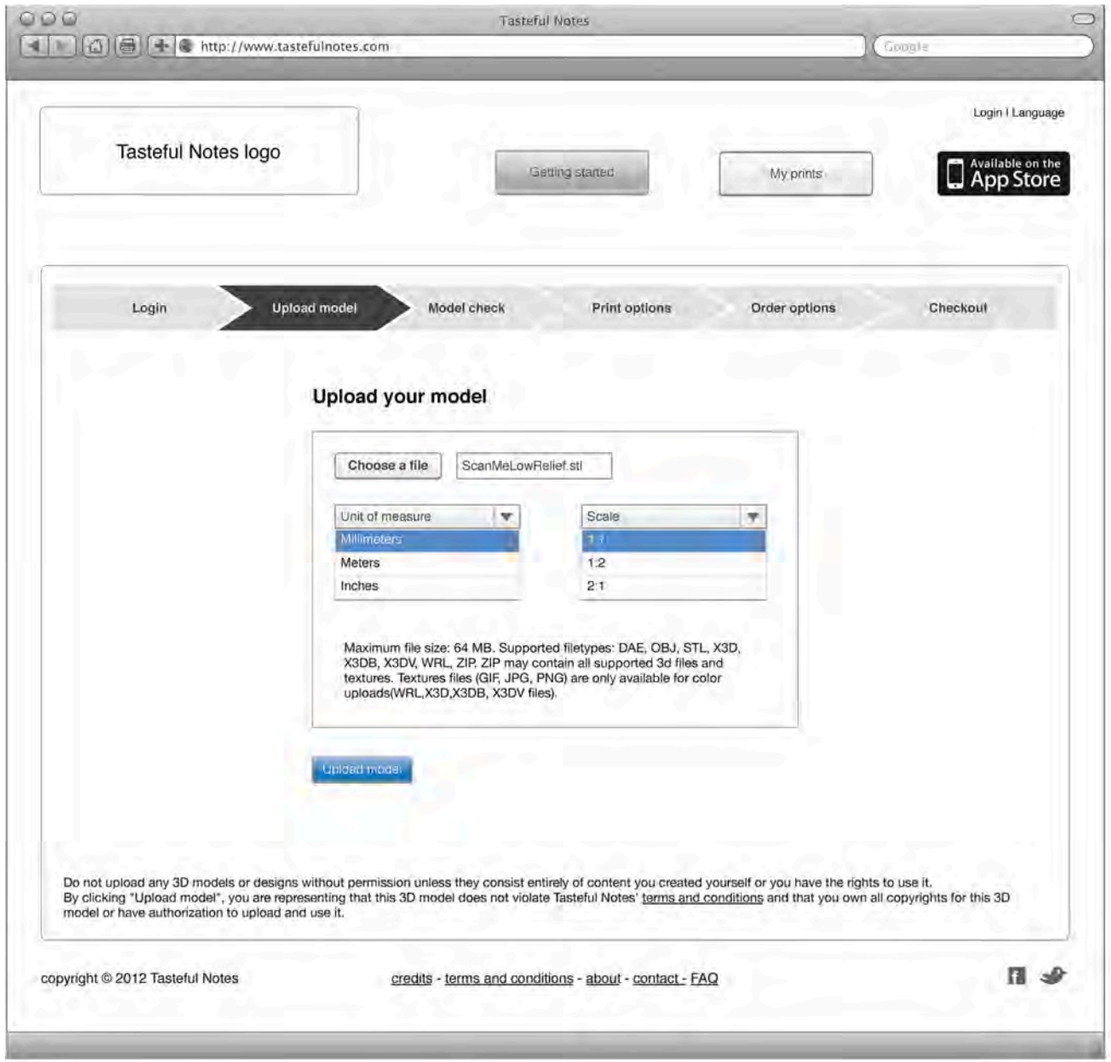
See the following images.

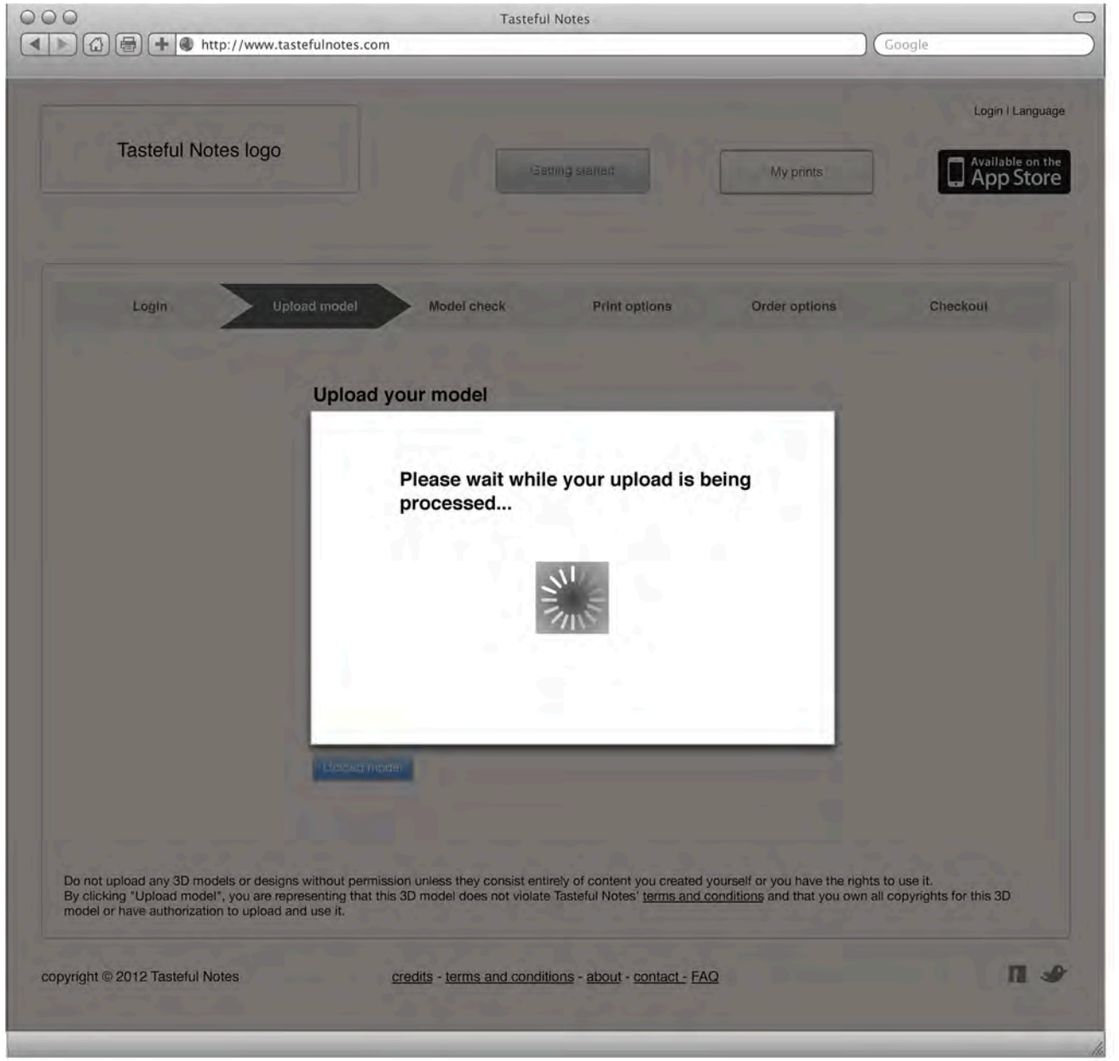
59 For prototyping the wireframes the application OmniGraffle was used: http://www.omnigroup.com/products/omnigraffle/ (4/7/2012).

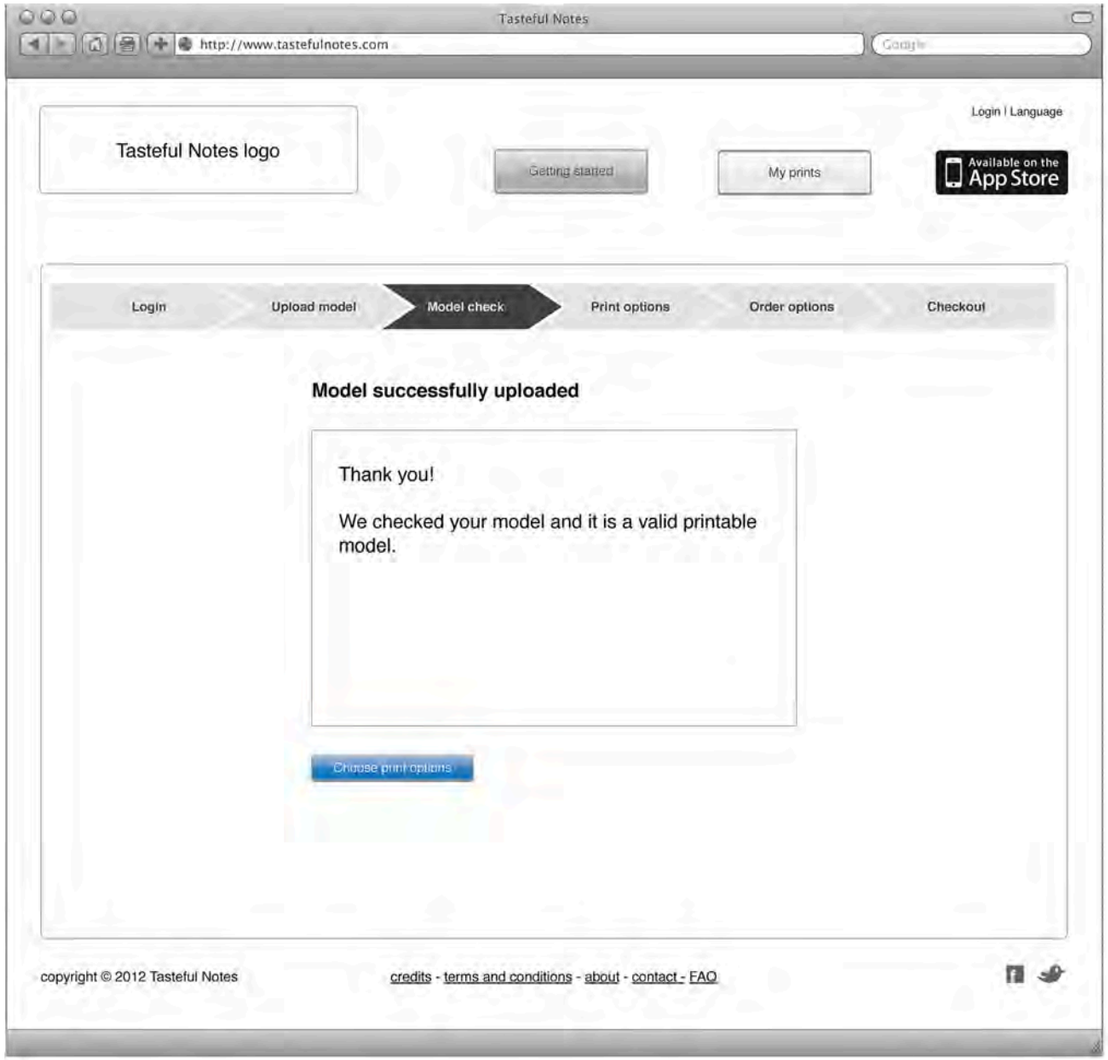


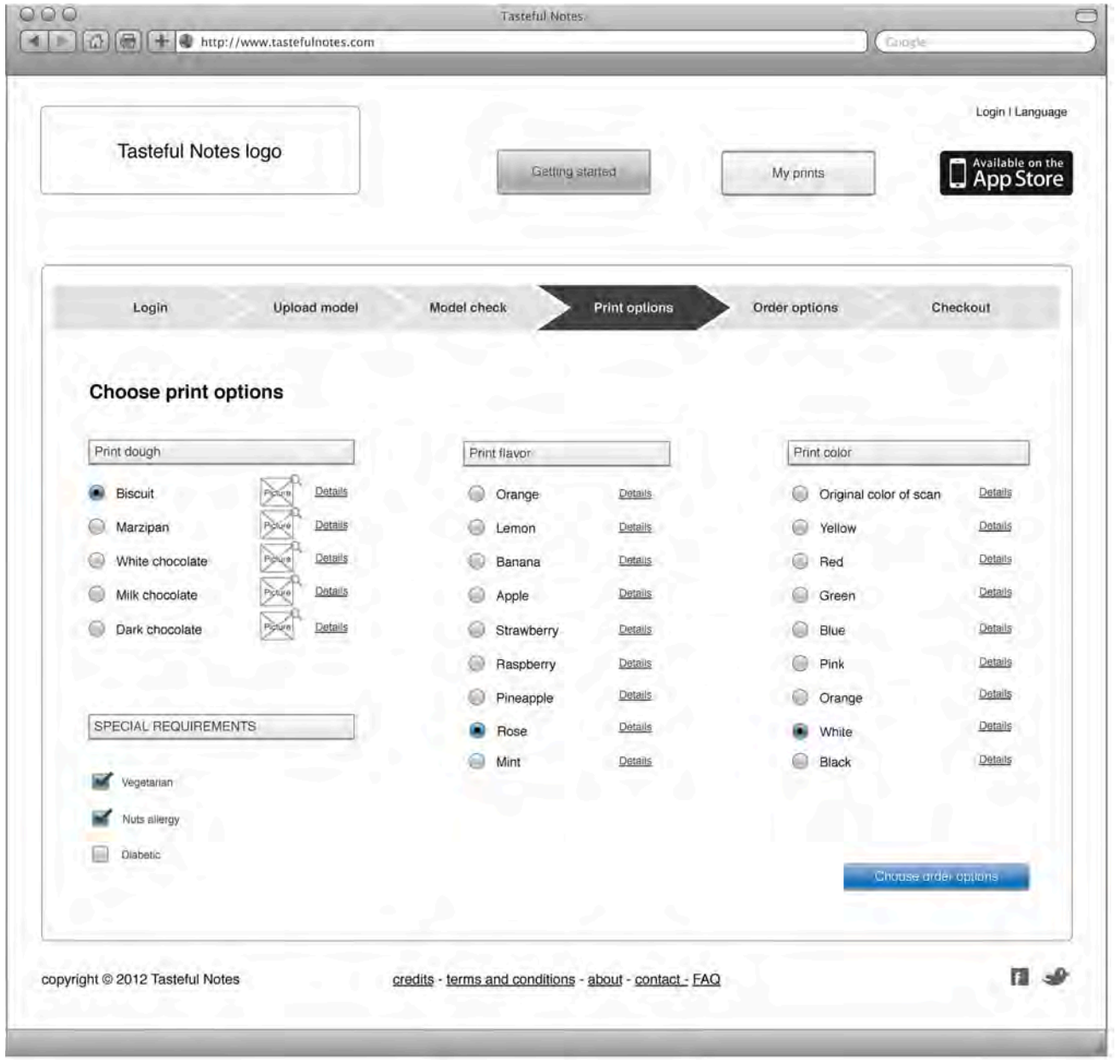

Tasteful Notes
http://www.tastefulnotes.com
Tasteful Notes logo
Login | Language
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Login to upload your model
Not already a member?
Create an accout
Username
text
Password
Login
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ

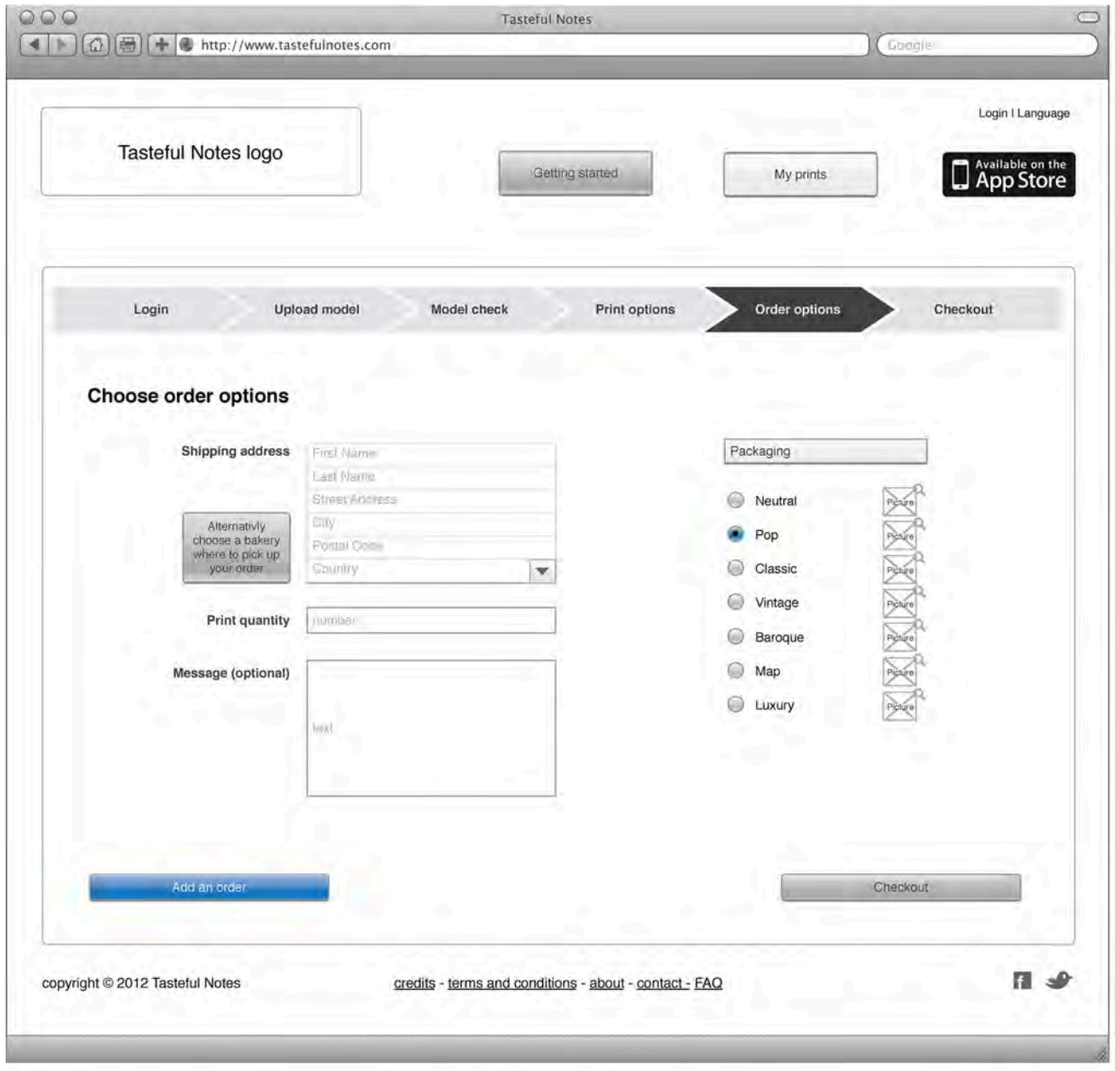

Tasteful Notes
http://www.tastefulnotes.com
Tasteful Notes logo
Login | Language
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Upload your model
Choose a file
No file chosen...
3D Model
2D Model
Maximum filesize: 64 MB. Supported filetypes: DAE, OBJ, STL, X3D, X3DB, X3DV, WRL, ZIP. ZIP may contain all supported 3d files and textures. Textures files (GIF, JPG, PNG) are only available for color uploads(WRL,X3D,X3DB, X3DV files).
Do not upload any 3D models or designs without permission unless they consist entirely of content you created yourself or you have the rights to use it.
By clicking "Upload model", you are representing that this 3D model does not violate Tasteful Notes' terms and conditions and that you own all copyrights for this 3D model or have authorization to upload and use it.
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ


Tasteful Notes
http://www.tastefulnotes.com
Google
Login | Language
Tasteful Notes logo
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Upload your model
Choose a file
ScanMeLowRelief.stl
Unit of measure
Millimeters
Meters
Inches
Scale
1:1
1:2
2:1
Maximum file size: 64 MB. Supported filetypes: DAE, OBJ, STL, X3D, X3DB, X3DV, WRL, ZIP. ZIP may contain all supported 3d files and textures. Textures files (GIF, JPG, PNG) are only available for color uploads(WRL,X3D,X3DB, X3DV files).
Upload model
Do not upload any 3D models or designs without permission unless they consist entirely of content you created yourself or you have the rights to use it.
By clicking "Upload model", you are representing that this 3D model does not violate Tasteful Notes' terms and conditions and that you own all copyrights for this 3D model or have authorization to upload and use it.
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ


Tasteful Notes
http://www.tastefulnotes.com
Google
Login | Language
Tasteful Notes logo
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Upload your model
Please wait while your upload is being processed...
Upload model
Do not upload any 3D models or designs without permission unless they consist entirely of content you created yourself or you have the rights to use it.
By clicking "Upload model", you are representing that this 3D model does not violate Tasteful Notes' terms and conditions and that you own all copyrights for this 3D model or have authorization to upload and use it.
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ


Tasteful Notes
http://www.tastefulnotes.com
Google
Tasteful Notes logo
Login | Language
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Model successfully uploaded
Thank you!
We checked your model and it is a valid printable model.
Choose print options
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ


Tasteful Notes
http://www.tastefulnotes.com
Google
Tasteful Notes logo
Login | Language
Getting started
My prints
Available on the App Store
Login
Upload model
Model check
Print options
Order options
Checkout
Choose print options
Print dough
Biscuit
Marzipan
White chocolate
Milk chocolate
Dark chocolate
Picture
Details
Print flavor
Orange
Lemon
Banana
Apple
Strawberry
Raspberry
Pineapple
Rose
Mint
Print color
Original color of scan
Yellow
Red
Green
Blue
Pink
Orange
White
Black
SPECIAL REQUIREMENTS
Vegetarian
Nuts allergy
Diabetic
Choose order options
copyright © 2012 Tasteful Notes
credits - terms and conditions - about - contact - FAQ



4.2.4 iPhone Application

Application mission and goals

The application for the iPhone is one of the touchpoints of the service, where the user is able to take or load a 2D picture as a model, upload it to the service and order edible prints by choosing selected options.

The goal of the application is to be easy to use while on the move and to guide the user seamlessly through the steps necessary to purchase the final product. The overall experience has to be very enjoyable and easy for the users, in order that they become returning costumers.

Users' profile needs and tasks

The application is conceived to reach a broad range of users of different ages and backgrounds. The overall structure of the application is simple and straightforward and does not require special knowledge, it has a clear and easy to use interface that takes advantage of the actions and gestures the users of iPhone smartphones are used to from other applications.

Visual design

The smartphone application was prototyped following Apple guidelines. The overall design (background, colors, font, images) follows the one of the webpage (see above), allowing for a consistent experience of the service.

Application Prototype

- Hardware: Apple iPhone 4;
- Software: Apple Keynote[60] with Keynotopia templates,[61] GoodReader[62] Application for the iPhone to view and test the clickable PDF on the phone.

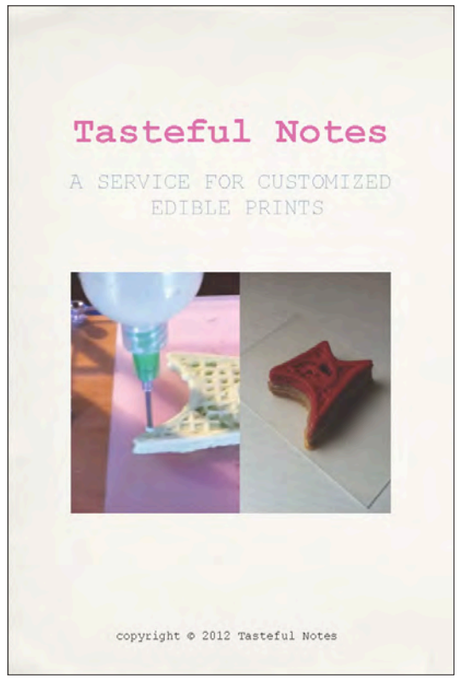
The decision to prototype the application for the iPhone was made because it is currently the biggest and better-developed application store and offers clear guidelines for the design. The application offers less options than the website, it is focused on ordering easily edible prints by uploading 2D pictures as models. The application makes use of the built-in camera and "Camera Roll" of the phone, the built-in GPS that allows geolocation as well as the "Contacts" stored on the phone.

Not all screens of the application were prototyped, a main workflow was chosen in order to demonstrate the main functions: the workflow where the experienced user takes a picture, uploads it to the service and chooses some options for the printing and the delivery of the final product. The checkout procedure with the payment is not prototyped. Also the screen reachable trough the "Info" button is not part of the prototype: it would offer detailed instructions on how to use the application, information about the ingredients used in the prints, and a direct link to the website of the service.

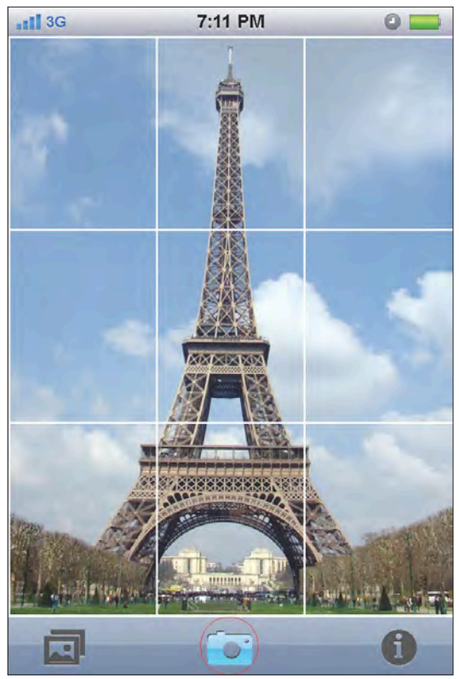
The final iOS application has to be developed using Apple's IDE Xcode.

Prototype of selected screens (the actions of the user are marked in red in the printed version below):

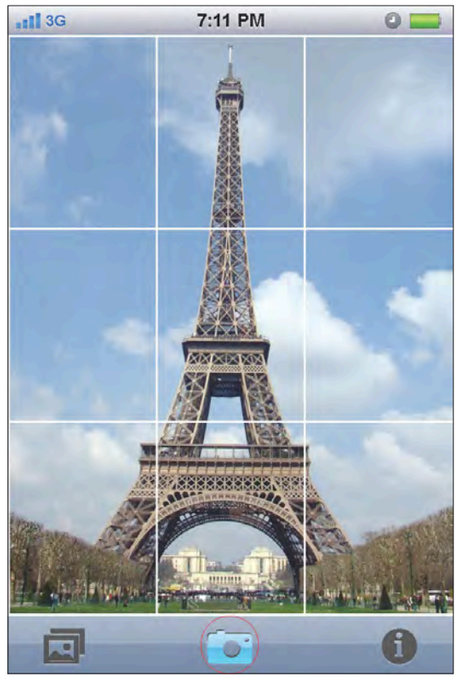
60 http://www.apple.com/iwork/keynote/ (4/7/2012).
61 http://keynotopia.com/ (4/7/2012).
62 http://www.goodiware.com/goodreader.html (4/7/2012).

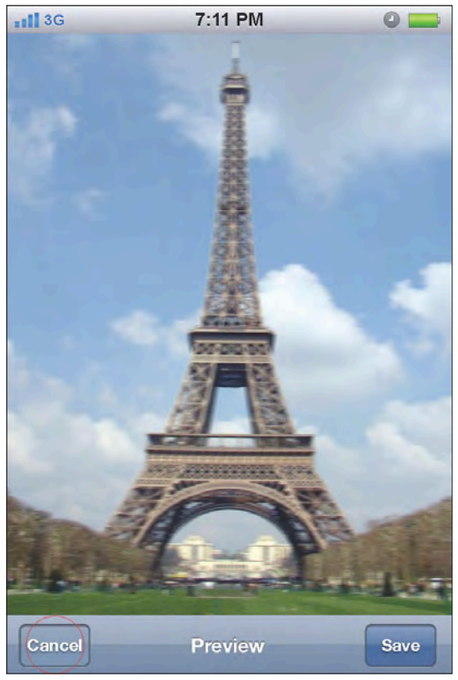

Tasteful Notes
A SERVICE FOR CUSTOMIZED EDIBLE PRINTS
copyright © 2012 Tasteful Notes


3G
7:11 PM
Take a picture or load it from your Camera Roll

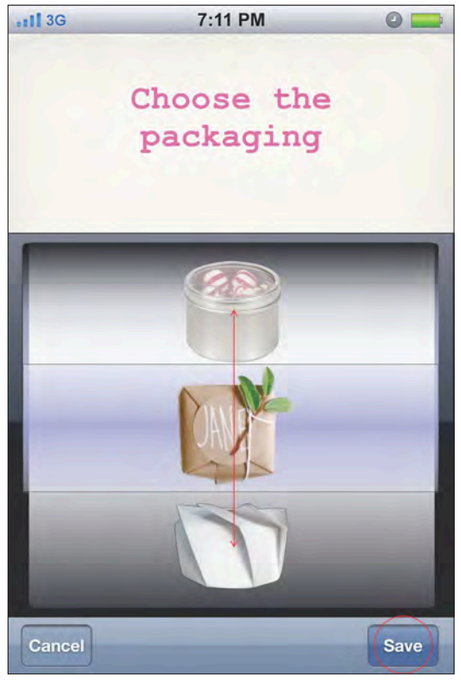

3G
7:11 PM


3G
7:11 PM
Cancel
Save

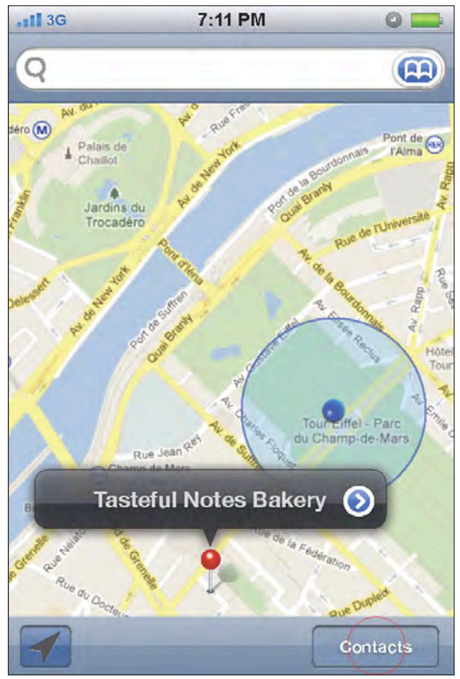

3G
7:11 PM

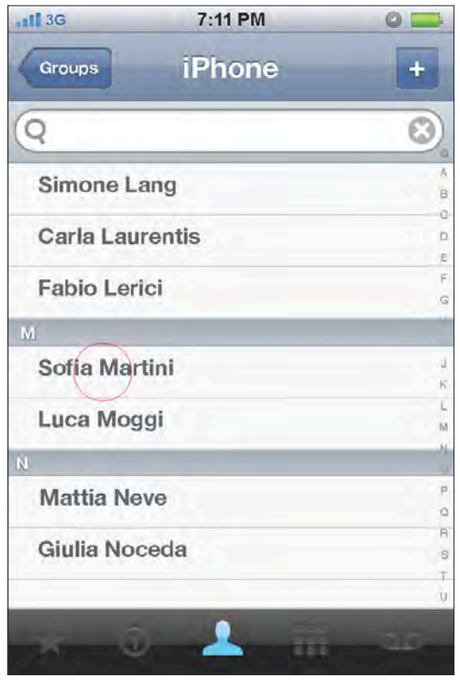

3G
7:11 PM
Cancel
Preview
Save

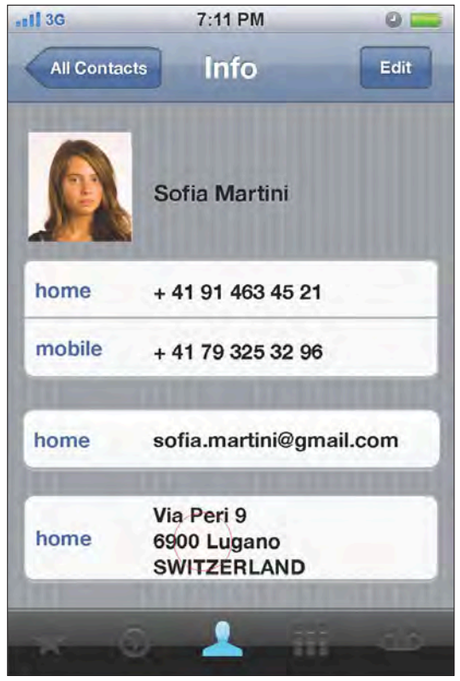

3G
7:11 PM
Choose dough and flavour
Biscuit
Marzipan
White chocolate
Milk chocolate
Dark chocolate
Orange
Banana
Strawberry
Rose
Mint
Cancel
Save


3G
7:11 PM
Choose the packaging
Cancel
Save


3G
7:11 PM
Choose where to
pick up
or let ship
your prints
Find a bakery
Contacts


3G
7:11 PM
Palais de Chaillot
Jardins du Trocadéro
Pont de l'Alma
Quai Branly
Rue de l'Université
Av. de la Bourdonnais
Av. de New York
Pont d'Iéna
Port de Suffren
Tour Eiffel - Parc du Champ-de-Mars
Rue Jean Rey
Tasteful Notes Bakery
Contacts

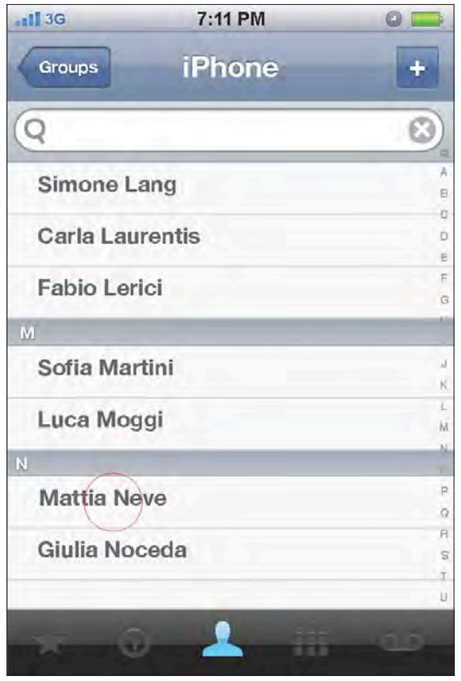

3G
7:11 PM
Groups
iPhone
+
Simone Lang
Carla Laurentis
Fabio Lerici
M
Sofia Martini
Luca Moggi
N
Mattia Neve
Giulia Noceda


3G
7:11 PM
All Contacts
Info
Edit
Sofia Martini
home
+ 41 91 463 45 21
mobile
+ 41 79 325 32 96
home
sofia.martini@gmail.com
home
Via Peri 9
6900 Lugano
SWITZERLAND

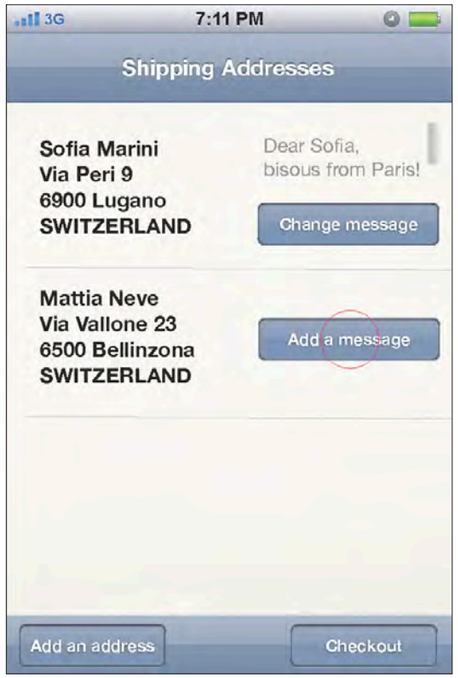

3G
7:11 PM
Shipping Addresses
Sofia Martini
Via Peri 9
6900 Lugano
SWITZERLAND
Add a message
Add an address
Checkout


3G
7:11 PM
Type in
a message
Dear Sofia, bisous from Paris!
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
.,123
Space
OK


3G
7:11 PM
Shipping Addresses
Sofia Marini
Via Peri 9
6900 Lugano
SWITZERLAND
Dear Sofia,
bisous from Paris!
Change message
Add an address
Checkout

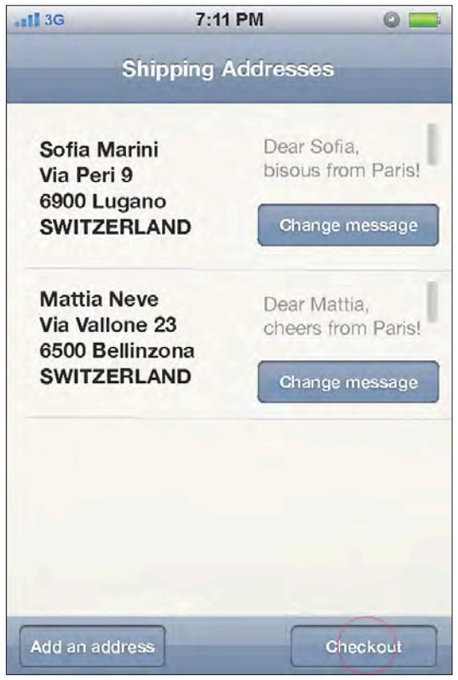

3G
7:11 PM
Groups
iPhone
+
Simone Lang
Carla Laurentis
Fabio Lerici
M
Sofia Martini
Luca Moggi
N
Mattia Neve
Giulia Noceda


3G
7:11 PM
All Contacts
Info
Edit
Mattia Neve
home
+ 41 91 635 77 23
mobile
+ 41 79 645 29 81
home
mattia.neve@gmail.com
home
Via Vallone 23
6500 Bellinzona
SWITZERLAND


3G
7:11 PM
Shipping Addresses
Sofia Marini
Via Peri 9
6900 Lugano
SWITZERLAND
Dear Sofia,
bisous from Paris!
Change message
Mattia Neve
Via Vallone 23
6500 Bellinzona
SWITZERLAND
Add a message
Add an address
Checkout


3G
7:11 PM
Checkout
PayPal
MasterCard
VISA
AMERICAN EXPRESS
DISCOVER
FINANCIAL SERVICES
Login
New Account


3G
7:11 PM
Type in
a message
Dear Mattia, cheers from Paris!
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
.?123
Space
OK


3G
7:11 PM
Shipping Addresses
Sofia Marini
Via Peri 9
6900 Lugano
SWITZERLAND
Dear Sofia,
bisous from Paris!
Change message
Mattia Neve
Via Vallone 23
6500 Bellinzona
SWITZERLAND
Dear Mattia,
cheers from Paris!
Change message
Add an address
Checkout

4.3 Usability Tests

For the usability test different users worked with the following three different options for scanning:

- picture with the iPhone;
- low relief scan with the Kinect;
- full 3D scan with the Kinect.

In making them try different options, a variety of issues are discussed, such as what are the positive and the negative aspects of each option, and how easy or difficult the handling of the scanning is.

The results of the test are summarized and an overview of the insights is provided. These results and insights are used for evaluating the acceptance and ease of use of the single parts of the service. The insights are also useful in order to know how to optimize the service.

Picture with the iPhone

For this test the users were able to use the working prototype of the application directly on an iPhone 4: the clickable PDF running in the GoodReader application allowed them to navigate through the application in real time by touching the screen.

The option "take a picture with an iPhone" was in general perceived as very easy and intuitive to use. Every one of the users had previous experience with a smartphone, those owning an iPhone felt very familiar with the interface and the interaction modalities, but also the ones that never used an iPhone before knew what to do immediately with no need of explanations.

Low relief scan with the Kinect

For this test a Microsoft Kinect for Xbox 360 connected to a MacBook Pro 2011 notebook was used together with the software needed for taking the low relief scan already installed.

For taking the low relief scan the Kinect must stand in a definite position and must not be moved: the users quickly found the best ways to position the Kinect in order to capture their scans (often using books or boxes to adjust the height). Finding objects suitable for the scanning was more difficult: they have to be not too small and appropriate for a low relief scan. Many users preferred taking a scan of themselves rather than of an object.

A blanket or a cardboard were used as a background for most of the scans, because it made it easier to isolate the object to scan.

Since the Processing code used for taking the scan requires using the up and down arrow keys to adjust the z-threshold to isolate the object to scan, as well as the space bar to save the result in a STL file suitable for printing, the users that chose to scan themselves felt it tricky to take the scan in the desired position and at the same time to manipulate the keyboard of the laptop. A solution for that problem was found by using the application for iPhone "HippoRemote",[63] that allows to control the keyboard of the computer remotely and wirelessly, allowing the users to stand back from the laptop, choosing the wanted position for the scan and to click the required buttons from the distance just holding the iPhone.

63 http://hipporemote.com/ (7/7/2012).

Full 3D scan with the Kinect

For this test a Microsoft Kinect for Xbox 360 connected to a HP desktop computer was used, together with the software needed for taking the full 3D scan already installed.

For taking a full 3D scan the Kinect must capture the whole object, which means that either the object or the Kinect have to be moved. Often it is also necessary to scan the same view of the object more than once in order to allow the software to produce a more precise scan. This required some practice from the users. The best method was to first position the Kinect at the right distance from the object and to rotate the object several times in front of the Kinect. For doing that, the following methods were used: placing the object on a large and thick cardboard and rotating carefully the cardboard, or placing the object on a turning structure like a potter's wheel or a turning tray and attach some long sticks to it to control the spinning movement from a certain distance in order to avoid interfering with the scanning process. In most cases this allowed to scan most parts of the object, but some parts i.e. those in shadow or too high to be reached from the position where the Kinect was standing, needed to be captured by taking the Kinect in the hands.

This was the most difficult part, because the Kinect is not designed to be hold and moved around. Also to create a handle or similar for allowing a better handling was an option discarded at the end because the stand and the upper part of the Kinect are joined together by an element with a motor that moves to adjust automatically to the different conditions, and this makes the whole device very delicate.

Another difficulty is to find objects suitable for the 3D scanning: in order to be recognized properly by the software they have to feature not too regular shapes, to have few hollow parts, and to cast little or no shadows.

Another point that was criticized by the test persons was the interface of the ReconstructMe software that allows the real-time 3D scan: it is not intuitive to use the first time because it is necessary to write commands in a console.

Insights

The option "take a picture with an iPhone" was expectedly the easiest to use for the test persons. It did not require special hardware, just a smartphone, with which all test persons where familiar with. Also the interface and the interaction modalities were clear and simple to use for everyone.

Taking scans with the Kinect sensor required more expertise. This because for most of the test persons it was an unknown device and also because the Kinect itself is not being designed for the purpose of taking scans. Also the software used for the tests was not adapted for commercial use. Nevertheless the tests showed that using some tricks and after gaining some practice, the users were able to take very satisfying scans and that the acceptance rose with every successful attempt. The low relief scans were generally easier to take than the full 3D scans.

These insights show that for most of the users probably the use of the iPhone application is the first choice. The 3D scans re-

quire more adventurous users that are also willing to experiment. It is also even more clear that it would be crucial to offer good tutorials and advices on the website on how to best take 3D scans, or consider to offer to the customers dedicated software with an easy to use interface and hardware adapted to the use of home scanning, especially developed for the service.

For the users interested in 3D scans but not willing to do them themselves, the bakeries provide the necessary service. Here it is important to show on the website good pictures of the possibilities offered by the 3D scans for creating interesting edible 3D prints in order to attract the users to either try for themselves or to visit the bakeries.

4.4 Conclusion

The aim of this project is to conceive and prototype a service that takes advantage of the new availability and widespreadness of technologies for 2D and 3D scanning and printing and offers to the customers an enjoyable and personal way to exchange information through easy to achieve customization of the final product and a pleasant and seamless user experience through all the touchpoints.

The outcome of the project is "Tasteful Notes", a multi-touchpoint service that allows customers to order customized edible prints. Users have the option to create and upload 2D or 3D models for the printing, either by themselves using the dedicated website or the application for iPhone, or to get personal and professional advice and help by letting produce the scanning and the printing of the models in specialized bakeries.

The personalization is given by the fact that the customers can choose the subject they want to print by taking (or letting take) a picture or a 3D scan of it. In addition, they can choose between different options for the edible prints like scale, dough, flavor, color, absence of ingredients not suitable for certain categories of persons, as well as options for the delivering like print quantities, packaging, personal messages, and finally they can choose to let the products be shipped at given addresses or to be picked up at a bakery. The application offers less options than the website. The bakeries allow for the greatest amount of options and personalization, providing advanced devices for creating the models for the printing and allowing special, non-standard options for special requirements. The printing takes place in the bakeries as well as in specialized factories of the service. In the factories also the main logistics of the service is taken care of and the on-line orders processed.

The service allows interesting ways to relate with other persons or groups of persons and capacitate people to exchange messages, convey and express feelings in a personal and powerful way. It allows different interaction modalities for different users, tasks and conditions of use. The overall user experience is coherent and seamless through the different channels, the users have the choice between different modalities and possibilities to obtain the final product, based on their needs and preferences.

The initial assumption that the new availability and widespreadness of technologies for 2D and 3D scanning and printing would contribute to create demand and acceptance for a service where customization and information exchange can be performed using those technologies was confirmed by user tests.

In general, the domains of "scanning" and "printing", both 2D and 3D, are experiencing a tremendous development and expansion, with technologies that just few time ago were confined to the professional sector now becoming more and more accessible to the large public and with special domains as "food printing" emerging. Here the potential for improvements and developments is very high.

The service presented here just shows a fraction of the potential of those new technologies, also in the domain of customization and in the exchange of objects, information and emotions that come with them between people in an every day more "connected" – but often not in a tangible way – world.

References

D. Bachfeld – P. König – V. Zota, *Kopieren in 3D. Räumlich scannen mit Digitalkamera, Kinect oder Laser-Scanner*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 86–91.
G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012.
S. Crist (ed.), *The Polaroid Book. Selection from the Polaroid Collection of Photography*, Taschen, Köln 2011.
R. Klanten – S. Ehmann – V. Hanschke (eds.), *A Touch of Code. Interactive Installations and Experiences*, Gestalten, Berlin 2011.
P. König, *Zauberkästen. Sieben 3D-Drucker im Test*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 92–101.
P. König – A. Barczok, *3D-Druckdieste auswählen*, in: *c't Hardware Hacks* (2012), nr. 1, pp. 134–145.
B. van Abel – L. Evers – R. Klaassen – P. Troxler (eds.), *Open Design Now. Why Design cannot Remain Exclusive*, BIS Publishers, Amsterdam 2011.

Tasteful Notes: A Service for Mass Customized Edible Prints

Standard Project Description

Author
Consuelo Keller

Issued from
CAS 4 of the Master of Advanced Studies in Interaction Design, SUPSI

Tutor
Fred Voorhorst

Year
2012

Abstract
Tasteful Notes is a multi-touchpoint service that allows customers to order customized edible prints. Users have the option to create and upload 2D or 3D models for the printing, either by themselves using the dedicated website or the application for iPhone, or to get personal and professional advice and help by letting produce the scanning and the printing of the models in specialized bakeries.

The personalization is given by the fact that the customers can choose the subject they want to print by taking (or letting take) a picture or a 3D scan of it. In addition, they can choose between different options for the edible prints like scale, dough, flavor, color, absence of ingredients not suitable for certain categories of persons, as well as options for the delivering like print quantities, packaging, personal messages, and finally they can choose to let the products be shipped at given addresses or to be picked up at a bakery. The application offers less options than the website. The bakeries allow for the greatest amount of options and personalization, providing advanced devices for creating the models for the printing and allowing the fulfillment of special requirements. The printing takes place in the bakeries as well as in specialized factories. In the factories also the main logistics of the service is taken care of and the on-line orders processed.

Interface and interaction modality
The service allows different interaction modalities for different users, tasks and conditions of use. It offers different touchpoints for the customers: a website, an iPhone application, and specialized bakeries.

The website offers a self-explanatory and coherent way to navigate trough the content. The service in general and its functions are well and clearly explained, by words as well as visually, by pictures and videos. The users have different options for creating their models to be uploaded to the service. They can take 3D scans by themselves downloading the appropriate software and using a special sensor, or they can use 2D pictures as models. After uploading the models the users are guided through the steps for choosing the print and the ordering options. A section dedicated to the bakeries provides maps to easily locate and reach them.

The iPhone application allows the users to take or load a 2D picture as a model, upload it to the service and order edible prints by choosing selected options. It has a clear and easy to use interface designed following Apple guidelines that takes advantage of the actions and gestures the users of iPhone smartphones are used to.

Technology

The service requires different technologies. For the home 3D scanning a special sensor has to be used together with different software.

The bakeries have to provide professional equipment for scanning. The factories as well as the bakeries feature special food printers for printing out edible 2D pictures and 3D objects.

The website has to be implemented using the newest web standards, HTML5 and CSS3. The iOS application for iPhone has to be developed using Apple's IDE Xcode.

User experience

The overall user experience is coherent and seamless through the different touchpoints. The users have the choice between different modalities and possibilities to obtain the final product, based on their needs and preferences.

The website is conceived to reach a large range of users of different backgrounds. The structure of the site is simple and as much self-explanatory and coherent as possible, and guides the users through the steps necessary to purchase the final product. The clean layout and the use of colors and fonts help the readability. The site is built to offer a satisfying and enjoyable experience for the first time users as well as for the returning customers.

The iPhone application is easy to use while on the move, guiding the users through the steps necessary to order the final product. The overall experience is enjoyable and conceived for a broad range of users. The structure of the application is simple and straightforward and does not require special knowledge. The design follows the one of the webpage, allowing for a consistent experience of the service.

In the specialized bakeries the customers can get personal and professional advice for creating the models for the printing and can also delegate the work of creating them. They can let print their models on site and pick up their orders directly.

Research and development context:

The domains of "scanning" and "printing", both 2D and 3D, are experiencing a tremendous development and expansion. Technologies that were confined to the professional sector are now becoming more and more accessible to the large public and special domains such as food printing are emerging.

The service presented here shows some of the great potential of those new technologies, also in the domain of customization and in the exchange of objects, information and emotions among people.

Main references

D. Bachfeld – P. König – V. Zota, *Kopieren in 3D. Räumlich scannen mit Digitalkamera, Kinect oder Laser-Scanner*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 86–91.

G. Borenstein, *Making Things See*, O'Reilly, Sebastopol 2012.

P. König, *Zauberkästen. Sieben 3D-Drucker im Test*, in: *c't Magazin für Computer und Technik* (2012), nr. 11, pp. 92–101.

P. König – A. Barczok, *3D-Druckdieste auswählen*, in: *c't Hardware Hacks* (2012), nr. 1, pp. 134–145.

B. van Abel – L. Evers – R. Klaassen – P. Troxler (eds.), *Open Design Now. Why Design cannot Remain Exclusive*, BIS Publishers, Amsterdam 2011.

Consuelo Keller

Consuelo Keller grew up in Lugano and in 2004 gained a MA degree in Classical Archaeology, Ancient History and Near Eastern Archaeology from the University of Basel. While studying she was an assistant at her department, participated to archaeological excavations in Switzerland, Italy and Jordan, and collaborated with different museums and cultural institutions.
After graduating she worked for ProSpect GmbH, a company specialized in services and communication in the cultural field. From 2008 to 2011 she was a scientific collaborator at the University of Basel in a project funded by the Swiss National Science Foundation (SNSF).
To deepen her strong interests in design related disciplines, along with her professional practice in 2007–2008 she gained the postgraduate Master of Advanced Studies in Digital Design and Management of the University of Applied Sciences and Arts of Lucerne. There she acquired competencies in the fields of graphic and product design, with focus on the digital instruments for planning and production and in the design management sector. This study contributed to arouse many interests as – among others – the open source movement, digital fabrication and mass customisation, interactive tools for museums and cultural sites and the human-machine interaction in general.
She decided to study interaction design because she is convinced that in this interdisciplinary filed she can merge her broad cultural, design and technological interests and apply her disparate theoretical, methodological and technical competencies.

Fred Voorhorst

Fred Voorhorst holds a Master of Science in Mechanical Engineering, and a PhD in Industrial Design Engineering, both from the Delft University of Technology and completed a Post Doc at the ETH Zurich in the field of man-machine interaction. His academic research focuses on intuitive interaction in the tradition of Gibsons's Ecological approach to visual perception, which he applies to a wide field, ranging from medical tools & devices to consumer products, Virtual Reality and Augmented Reality systems. He is teaching interaction design at BSc course of Industrial Design Engineering at the University of Arts and Design Zurich as part of the human factors module he is coordinating.
In his professional career he has worked in various companies (mainly) in the IT sector, and occasionally in the field of high-end fashion. Positions are diverse but always within the area of process, product development and/or business development, bringing in a strong customer focus. Currently he holds a part time position at the SUPSI/ICIMSI, and the remaining time he is working as independent on innovation and project management for various companies.