Co-lab OpenPlant - interdisciplinary workshops of science art and design

Paolo Bombelli
pb346@cam.ac.uk

The Idea

Co-lab OpenPlant is a series of three workshops and a hackathon event with the objectives of creating new ideas around plant synthetic biology applications and fostering further collaboration by establishing links between designers, artists and scientists. Our workshop is a place where artists, designers, and scientists meet to initiate collaboration. We aggregate designers to learn science. We encourage scientists to value and learn artistic approach and design thinking.

Who we are

1. Paolo Bombelli, postdoc in Biochemistry (university of Cambridge) pb346@cam.ac.uk
2. Paloma Portela Torres (Molecular Biology BSc Student at UCL), palomaa8@gmail.com
3. Lena Asai (Design BA Student at Goldsmiths, London), lenaasai.design@gmail.com
4. Juan Manuel García Arcos (MSc student at CRI, Paris, Interdisciplinary Biology and Education) juanmagarciaarcos@gmail.com
5. Ke Fang (PhD student at CRI, Paris, Interaction Design and Physics), ke.fang@cri-paris.org

Dr Paolo Bombelli, Biochemistry, University of Cambridge:
Paolo has a multidisciplinary background with specific interests in energy conversion, photosynthesis and electrochemistry. Since 2007 he has been pioneering the development of algal solar panels known as Bio Photo Voltaic (BPV) systems3, featured in national and international press. He is currently a postdoctoral fellow in the Department of Biochemistry at Cambridge with the title of “algal electrician”. With the aim to boost the noesis on micro algae and promote these organisms as platform for biotechnological applications and synthetic biology studies, I am contribution to implement a project name “Big Alage Open Experiment”. Having successfully secured an OpenPlant grant (October 2015) I am working to complete and deliver this exiting venture.

Paloma Portela Torres (Molecular Biology BSc Student at UCL).
She will start a PhD next year in cell biology at the MRC LMCB at UCL. With a background in biotechnology, Paloma participated in iGEM with the UCL project "mind the gut" and she is a photographer in her spare time. She participated in the workshops since the first edition last year.

Lena Asai (Design BA Student at Goldsmiths, London).
Design student in last year at Goldsmiths school in London (UK), she is memeber of the biohackspace and participant in the iGEM competition last year. She is focusing her studies on the collaboration between innovation and biology and design. She participated in the workshops since the first edition last year.

Juan Manuel García Arcos (MSc student at CRI, Paris, Interdisciplinary Biology and Education).
He is a research fellow in education sciences in the Center for Research and Interdisciplinarity of Paris. He holds a bioengineering degree (Sevilla, Spain) and a masters in synthetic biology, but got interested into new teaching methods and science communication since last year. He participated in the workshops since the first edition last year.

Ke Fang (PhD student at CRI, Paris, Interaction Design and Physics).

Ke is a PhD student in the Center for Research and Interdisicplinarity of Paris. He is currently doing a PhD in the interaction between science, art in design. He holds a degree in Physics by Beijing University and a masters degree in Human Computer Interaction design by Tsinghua University (Beijing, China). He participated in the workshops since the first edition last year.

Implementation

'Co-Lab' (or "collaboration" in Japanese) Openplant is a hands-on workshop, led by designers and scientific researchers, aiming to foster the creation of interdisciplinary projects around plant synthetic biology with art and design. This concept was proposed by scientists and designers in Paris and London around the association Open Science School. Co-lab events can be seen at: www.openscienceschool.com/co-lab

About previous Co-Lab workshops:

We have previously organized three successful events that took place in Paris (France), London (UK) and Shenzhen (China). Those events received the support of Makerversity, the Center for Research and Interdisciplinarity of Paris (CRI), the Institute of Making (UCL) , the EPSRC and Open FIESTA in Tsinghua University in China. The result was very inspiring and gave us a excellent feedback for refining our aims and methodology. The events attracted more than 60 participants, including people from University of Malmö (Sweden) and University of Marburg (Germany) that came specially for the workshops in London and Paris.

Details of the event previously organized are given here below.

CO-LAB SYNTHETIC BIOLOGY

We had two Co-Lab Synthetic Biology workshops in November 2015, hosted in Biohackspace and Makerversity in London and Center for Research and Interdisciplinarity in Paris. In these two workshops, we had science lectures about synthetic biology, biology experiments and narrative design workshops for both scientists and designers. Some of the most experienced participants and journalists that came to the final presentations specially valued the originality of the format and the friendly and cooperative atmosphere. Please check the previous booklet for co-lab synthetic biology and a deep description on this link.

CO-LAB BIOWEAPON

We had a Co-Lab Bioweapon workshop in January 2016, hosted in the Open FIESTA Center at Tsinghua University in Shenzhen, China. Co-Lab Bio-weapon was aimed at building a bridge between designers and scientists through an unfamiliar concept to both communities, namely "weapon". The concept of "weapon" was the metaphor around which each of the groups built their final project. In the workshop, a synthetic biology lecture, a range of different experiments and an interaction design workshop were organised. Participants learned from each other and established in-depth discussions through the metaphor they were constricted by, which encouraged more profound connections between design and science.

CO-LAB BIOMATERIALS

We had two Co-lab Biomaterial workshops in London, hosted by the UCL Department of Biochemical Engineering and the Institute of Making and the support of the EPSRC through a Design-Lead Materials grant (more info: http://www.instituteofmaking.org.uk/research/design-led-materials) This workshop encouraged collaboration around applications and development of new biomaterials. We dedicated two days for laboratory experiments and group work followed by a day of prototyping at the Institute of Making. Participants were encouraged to design unconventional solutions and materialize them during the prototyping process.

About Co-Lab Open Plant workshops:

The structure of Co-Lab OpenPlant would be three weekends of workshops and an extra Hackathon weekend which would enable the participants from previous workshops to develop their projects further. Collaboration and group efforts in the Hackathon are intensified, hence serving as a good way to push the projects forwards from both science and design sides. We have also scheduled two weeks of independent laboratory work between the workshops and Hackathon for allowing further development of the core science within the projects.

We aim to initiate the publication of a journal with the purpose of documenting and circulating the processes and results of the workshop, whilst including broader reflections on the possibilities of collaboration between science, design and arts. As a first issue, the publication would feature the projects from the first three weeks and discussions on discovering the potential in interactions between scientists and creatives. We would also document the Hackathon from the final week as a way to showcase the way preliminary projects move forward through efforts from different approaches.

Science activities planned for the lab

- Plant pigment extraction: We will perform pigment extractions from natural plants and algae (betalain from beetroot, carotenoids from chili pepper, phycocyanin from spirulina, chlorophyll from spinach, indigo from Indigofera tinctoria). We can use this as a way to explain the function of metabolic pathways and ways to analyse our products.
- Electrophysiology lab: We will make plant pots wired internally with carbon electrodes. As the plant's roots grow, they will be in close contact with the electrodes and participants will see the current increasing over time. Not only it shows the link between electricity and life, but also creates an engagement with a scientific experiments that only will be completed and functional over the course of two weeks. we will encourage participants to post continuous reporting this experiment of the social media from home.

Plan

Co-lab OpenPlant workshops dates:

<table>
<tr><th></th><th></th><th>Friday</th><th>Saturday</th><th>Sunday</th><th>Monday</th></tr>
<tr><td rowspan="2">Week 1: Cambridge</td><td>AM</td><td></td><td rowspan="2">Workshop</td><td>Workshop</td><td></td></tr>
<tr><td>PM</td><td>Workshop</td><td>Short presentations</td><td></td></tr>
<tr><td rowspan="2">Week 2: Norwich</td><td>AM</td><td></td><td rowspan="2">Workshop</td><td>Workshop</td><td></td></tr>
<tr><td>PM</td><td>Workshop</td><td>Short presentations</td><td></td></tr>
<tr><td rowspan="2">Week 3: Cambridge</td><td>AM</td><td></td><td rowspan="2">Workshop</td><td>Workshop</td><td></td></tr>
<tr><td>PM</td><td>Workshop</td><td>Short presentations</td><td></td></tr>
<tr><td rowspan="2">Week 4</td><td>AM</td><td colspan="3" rowspan="2">Independent work in lab</td><td></td></tr>
<tr><td>PM</td><td></td></tr>
<tr><td rowspan="2">Week 5</td><td>AM</td><td colspan="3" rowspan="2">Independent work in lab</td><td></td></tr>
<tr><td>PM</td><td></td></tr>
<tr><td rowspan="2">Week 6: Cambridge</td><td>AM</td><td colspan="3" rowspan="2">Hackathon at Makespace Cambridge</td><td>Presentations</td></tr>
<tr><td>PM</td><td>Networking</td></tr>
</table>

Parts of the workshop

Over the three days, participants will be introduced to synthetic biology in the environment, with an special focus on plant genetics, algae, etc.

We will also invite some local experts and professors to give short talks about their topic, but keeping the space free for students to have peer-to-peer exchanges.

That will be completed with a design workshop, with the objective of showcasing the different methodologies and reasoning of different disciplines. This workshop is based on narratives stories that the participants will develop individually and then carry them to the group work that happens afterwards in order to enrich it more.

Then, participants will engage in groups from 3 to 5 people and work on a synbio-inspired project for two days, and create either a rapid physical prototype, a project proposal, or an object. A special focus will be dedicated to the documentation and presentation of their ideas.

We encourage one-to-one exchanges and an informal atmosphere, having ice-breaking sessions and informal pub meetings after Friday and Saturday's sessions.

Detailed schedule

This is the schedule for the openplant workshops . The workshops are centered around plant synthetic biology and how interdisciplinary thinking will help the development of future plants.

<table>
<tr><td>Co-lab OpenPlant</td><td>Friday</td><td>Saturday</td><td>Sunday</td></tr>
<tr><td>10am - 11am</td><td></td><td rowspan="2">How to read and write scientific references</td><td rowspan="2">Make an interdisciplinary project</td></tr>
<tr><td>11am- 12pm</td><td></td></tr>
<tr><td>1pm - 2pm</td><td></td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>2pm- 3pm</td><td rowspan="2">Introduction</td><td rowspan="4">Make an interdisciplinary project</td><td rowspan="2">Prototype your project</td></tr>
<tr><td>3pm - 4pm</td></tr>
<tr><td>4pm - 5pm</td><td rowspan="2">Science workshop: plant cell biology and genetics</td><td>Break</td></tr>
<tr><td>5pm- 6pm</td><td rowspan="2">Present and document your project</td></tr>
<tr><td>6pm - 7pm</td><td rowspan="2">Design thinking: find a problem</td><td rowspan="2">Science workshop: in silico cloning and protein 3D structure</td></tr>
<tr><td>7pm - end</td><td>Dinner</td></tr>
</table>

Benefits and outcomes

Our OpenPlant workshop brings artists, designers and scientists together to initiate collaboration and explore the possibilities of biological design. We aggregate designers, artists and scientists to learn about and explore plant and algae science, as well as synthetic biology. We encourage participants to adopt an artistic and design-focused approach whilst incorporating scientific insights into their work. The objectives align with the general pursuits of openplant funding to promote plant synthetic biology from an interdisciplinary methodology and will create open plant projects from a creative perspective, and hopefully build a community between scientists and designer interested in plant synthetic biology.

In the past Co-Lab workshops, we have attempted to generate valuable dialogues across disciplines. We now aim for the tangible integration of scientific and design methodologies. And how do we initiate cooperation beyond mere conversation? We believe in the development and achievement of synchronized goals for designers and scientists as the he next step for bona fide collaboration.

We aim to initiate the publication of a journal with the purpose of documenting and circulating the processes and results of the workshop, whilst including broader reflections on the possibilities of collaboration between science, design and arts. As a first issue, the publication would feature the projects from the first three weeks and discussions on discovering the potential in interactions between scientists and creatives. We would also document the Hackathon from the final week as a way to showcase the way preliminary projects move forward through efforts from different approaches.

Sponsor for the research and cost centre

Paolo Bombelli, Postdoc in Department of Biochemistry (University of Cambridge)

Budget

This is a preliminary budget based on our past experience on workshop organization:

	per person per workshop (£)	quantity	total per workshop (£)	No. of events	Total (£)
Tea and Coffee			150	4	600
Meal for organizers	5	15	75	4	300
Pizza and beer after workshop			100	3	300
Material for prototyping			200	3	600
Lab materials plant pigments			35	3	105
Lab materials bioelectricity			120.89	3	362.67
London - Cambridge	17	4	68	4	272
London - Norwich	25	4	100	1	100
Cambridge - Norwich	20	2	40	2	80
Paris - London	120	2	240	4	960
Hackathon funds			300	1	300
				TOTAL	3979.67
NOT INCLUDED IF HOSTED IN THE BIOMAKERSPACE					
Safety fees			150	1	150
Laboratory Booking			325	3	975
				TOTAL	1125

Breakdown of the cost of materials of the bioelectricity workshop:

Plastic cup (we can use plastic disposable glass): ca. £0.20 per unit
Minimum order quantity: none (and probably we can have them for free)

Anode (carbon fibre, ca. 5m): ca. £1.00 per unit
Minimum order quantity: 1 m2 (enough for ca. 25 systems), £25.80 (no shipping cost)

Cathode (Carbon paper –Pt): ca. £0.80 per unit
Minimum order quantity: 25 cm2 (enough for ca. 25 systems), £22.80 (no shipping cost)
NB: this one need to be ordered at least 4 weeks in advanced, the company making it could be quite slow!

Electric connector (Stainless-steel 316): ca. £0.05 per unit
Minimum order quantity: 1260 cm2 (enough for ca. 25 systems), £7.49 (shipping cost £3.50)

Tape (or glue) for connecting the different parts: ca. £0.20 per unit
Minimum order quantity: one roll (enough for ca. 60 systems), £8.00 (shipping cost £3.50)

Plant..... everyone could go and pick one from outside: free

Voltmeter (we probably need one every 3 people/group): ca. £50.00 (based on 3 voltmeters)
Minimum order quantity: none.

In total with minimum order quantity:
£25.80 + £22.80 + £11.30 + £10.99 + £50.00 (5 voltmeters) = £120.89

<u>Breakdown of the cost of materials of the pigment extraction workshop:</u>

Plastic cup (we can use plastic disposable glass): ca. £0.20 per unit or free
Minimum order quantity: none (and probably we can have them for free)

Ethanol 96% from drugstore: 1000ml ca. £25

Beetroot, spinach, carrot: £10 pounds

Paper and ink, included already in stationary materials.

In total with minimum order quantity:
£25 + £10 = £35 per workshop