On the open hardware documentation tool DocuBricks

OpenPlant Fund Project Title: Documentation Tool for Open Plant Technologies

Summary
We have successfully built an open source hardware documentation software and an online repository called DocuBricks (DocuBricks.com). We arrived at a software tool that is (according to feedback of users) easy to use and helpful in a wide range of hardware projects and saves documentations in a modular and accessible XML format. The database is citable and the first biology related documentations have been uploaded – many more are to follow from Open Plant Fund projects and the Open Science Hardware Movement. We will continue to develop DocuBricks to serve as a high quality repository for Open Science Hardware.

Report and Outcomes
We started off with the observation that open source hardware, especially in a biological and plant science context, is currently held back by hurdles of sharing hardware documentations – such as effort required to document a project, lack of quality guidance and control as well as expectation management. Documentations are the key information set to make hardware open source and reproducible. Within the scope of this grant, we build an extensive documentation tool DocuBricks to address many of the observed deficits. Here is a list of specific achievement in accordance to our original proposal and extending beyond it. All projects and download links can be found directly on DocuBricks.com:

- A open source software DocuBricks editor (desktop software in Java), that provides users with a framework to quickly document a project in a modular fashion with step-by-step assembly instructions for each module (called "Brick"), while dropping in images and other media files to support easy understanding by readers. The editor then saves the project in an accessible XML format together with a folder containing all design and media files.
- The authors of the documentation are guided by the editor software to structure and explain the project along its functionality (earlier referred to as "logical parts") and then indicate its implementation (earlier "physical parts"). This is a major difference to all other attempts known to us and significantly enhances the ability of later readers to understand design decisions and help evolving the project – this is continuously referred to as the key advantage of open source hardware.
- Modularity enables coexistence of incompatible licenses: Many licenses (such as the CERN license or CC-BY-SA) used for open source hardware are "share-alike" - meaning that the person modifying the project has to re-publish it under the same license. This creates problems when a project should be created and published, that builds on two

existing projects with different licenses. We solved another major problem here: One can give different licenses to the modular bricks of a project documented in DocuBricks (default: top brick license applies to all bricks lower in the bricks hierarchy).

- We have built an open source offline viewer (XML style sheet + java script and HTML), that displays the projects (XMLs + files) created with the DocuBricks editor interactively in a browser. The authors need not worry about style and layout when using our tools. The viewer is stand-alone and works without internet access – just right click on the XML file (must be in the same folder as the viewer software) and select: open with – Firefox browser. We have stopped developing the offline viewer recently in favor of an online viewer directly hosted on the website (see section on deviations from proposed grant plans).

- We have tested the tools on several examples, as have some project partners and we have iterated the software tools to be meet the practical needs and to be easier to use and understand. One example of added features is the option to include instructions with parts in the Bill of Materials (BOM). This provides an intuitive location to add e.g. post processing steps for 3D printed parts such as drilling into printed holes. Depending on where the parts are sourced, this might not be necessary to perform and thus would unnecessarily take up space in the assembly instructions of the main documentation.

- We have developed an online repository where projects documented with the DocuBricks editor can be uploaded and shared (and soon be displayed online - on the new website we are writing). As proposed, this website is citable via digital object identifiers (DOIs). These are permanent, internationally curated links and the standard for referencing in the academic community. We believe a functional online repository based on a functional documentation format like ours is of great value to the community, because it allows users of hardware documentations to evaluate and extend on hardware in a much more meaningful way. This is both essential for successful open hardware development and for appropriate recognition of impact and re-use for contributors from the scientific community.

- We have also participated in a number of workshops and meetings, where we have pushed best practice guides, accessibility to hardware publications and tools, standards for the fields and information of the public. See our (new website soon) for major references to media reports.

Deviations from proposed grant plans
- Generally, user interactions and iterations of our software have confirmed our initial hypotheses on what tools are needed. The major exception is perhaps the evaluation of "stand alone" of our software tools. In order to make the software as open source and accessible as possible, we created the software as offline-desktop software, which can for example, can be version controlled and shared on GitHub. We learned that most users want interactive online tools instead and that most don't worry about the fact that this makes the software in itself less distributable and that we have to make sacrifices on version-controllability. Online tools require a different backend design and programming language, so this is a major re-direction for us.

- We were also proposing possible additions to the project, most notably an app and possible integrated rendering tools for CAD files. We have decided to not yet attempt these, as refining the documentation tool through iterations and guidance of initial users seems more essential. Instead, we are now integrating the Altmetrics tool, to provide journals with feedback on user interactions with design files and the documentation, to improve academic impact reports for Open Science Hardware. Hardware innovation in science is currently typically undervalued, which keeps many scientists from engaging in it.

I, Tobias Wenzel, want to thank the most amazing DocuBricks team, especially Johan Henriksson, for the exceptional work and commitment to the project. Thanks to the motivation and idealism to help the Open Science Hardware community as well as great teamwork, we have managed to create a very useful tool that is un-matched so far. I am confident that we invested our hundreds of hours of voluntary time, thought and discussion well into this open project.

Expenditure
The money has been spent on digital infrastructure (some hosting and domain fees), but mainly on getting programming help on tasks like setting up the website and database, as well as other specific front- and back-end tasks that were outsource-able and that the volunteer team could not find the time for. Without the openPlant grant, it would have been impossible to arrive at where we are now, as our very extensive volunteering commitment had to be mainly focused on the structure, programming and testing of the documentation tool itself as well as designing the structure for the database. Furthermore, smaller amounts of money have been used to test some external instructions practically (e.g. protein 3D printing, printing filament) and for workshops on enabling open hardware publishing and documentation best practices.

Are you claiming the additional £1000 follow-on funding? Yes

Follow-On Plans
We very much need all financial support we can get. We have not spent all of the 4000GBP yet, partially for administrative reasons, partially because a lot of design decisions had to be made to arrive at a point where we know specifically what we want, so that we can outsource some of the programming work (we cannot accomplish the whole project and repository set-up on our own voluntarily). With the follow-on funding, we also want to engage in further publication, communication and outreach for the tool, to make it more widely known and used. We will need and use the funds in the next weeks rather than months - the "deadline" of September 2016 suits us well. By that time, I can offer a detailed report.