Automating Documentation Considered Harmful (Some of the Time)

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This position paper aims at triggering a discussion around systems for automating maker's documentation in a learning contex and why that might be problematic or even harmful. We first describe the context of learning in makerspace and the importance of documenting, in particular regarding the fact that it enables makers to reflect on their process. We then discuss the difficulties of documenting and the potential benefits of automating some parts of the process. Finally, we question whether these automated features, which simplify the process of documentation creation are necessarily beneficial for learners.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**.

Additional Key Words and Phrases: automation, documentation, portfolio, learning, reflection

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1 DOCUMENTATION IN LEARNING ENVIRONMENTS

Makerspaces are places where people learn by collaborating and exchanging between each other or with instructors on methods and techniques to build, repair, or invent things. These places are more and more used as an educative environment as the principle of learning by doing continues to gain in popularity [24]. One way to support learning is the practice of documentation and portfolio creation, which are web based documents describing one or several projects. Documenting in the context of makerspaces or Fablabs is a common practice to enable keeping track, reusing and sharing one's work [28]. As an education tool, it serves as assessment support and enables makers to reflect on their decisions at different levels: during and after the fabrication activity [4, 18, 19].

Despite the benefits of documenting, makers encounter different barriers: documenting is easily forgotten while focusing on making, and it requires a sequence of additional tasks which are difficult and time consuming, from the moment of the capture of information during the activity, to the sharing of the documentation [28]. As a result, many documentations are lacking details, missing information and do not include failures, preventing instructors as well as learners to have a precise view on the progresses and processes [14, 21]. While not all types of documents made by makers to represent a fabrication project are made to support learning, they are all affected by similar barriers: Makers must set up a scene by installing a camera, maybe a tripod to hold a phone or additional lights, capture the content, retrieve it and eventually author a document. Some research in HCI has attempted to address the above mentioned barriers by automating some of the steps towards documenting in makerspaces and tutorial creation [13, 20, 27, 29].

In this position paper, we want to raise the discussion on automation of documentation creation applied in a learning context. Automation of some properties in tutorial creation has been explored to favor the exhaustiveness of the explained process and to reduce the effort of the maker. However in the case of learning, the activity of documenting is in itself also a pedagogical tool, and automating the whole documentation might not be useful (or even harmful) in this peculiar case. This position paper seeks to raise the question of automated documentation, and we propose to include in the discussions of this workshop in how far automating parts of the documentation creation could be beneficial or harmful in a learning context, how to give control to the machine while giving the learner the opportunity to be conscious of the documenting process, or how to reduce the extra efforts while preserving the ones necessary to the progress and reflection of the maker. We think these questions would be relevant for the HCI community focused on learning through making.

We first explain why documenting matters and the barriers related to documenting in the context of learning and then explore different steps of the documentation process where automation of some features might help makers or not.

1.1 Why documenting to learn?

Documenting in the context of learning consists of creating traces during a project to represent it by communicating the methods, rationales, and the results obtained. Documentations or portfolios generally include visual support (photographs, screenshots, videos), audio and text [18, 22], organized temporally such that they illustrate the process and history of a project in a narrative way. In that sense, documentations as learning tools differ from tutorials as they aim to **include the troubleshoots**, the errors and how the errors were solved, instead of the perfect step sequence to achieve the result. These process-folios [18, 19] serve as assessment support as they enable instructors and facilitators to assess the progress of makers and their computational literacy. They also enable makers to **reflect on their process** [21], (***ON***—**action** [11, 23]) as they depict a broad view on the trajectories taken throughout the project. Ideally, documenting happens alongside the project to be used as a support for **receiving feedback by teachers or peers** [22], and also giving feedback to peers, allowing to reflect on one's own as well as other's work [4]. Documentations can also integrate a form of introspective or meta-cognitive dimension as described by the concept of reflective-folios [18]: during a particular period of time, they can allow students to engage and to **reflect on their own learning progress** at a higher level than the project [14]. At the scale of an activity, documenting is also a way to engage with the design process[4]: making intentional traces during an activity gives the opportunity to **step back** and to engage with the materials and tools, to **have a different point of view** of the activity while doing it and thus **reflecting—*IN*—action** [11, 23].

1.2 Why is documenting so hard?

Documenting is thus important in a learning context, however, doing it is difficult and tends to be forgotten or postponed [21], since makers are focused on their main fabrication activity, leaving the documentation activity in the background [8, 19]. This is even more frequent when problems occurs, and troubleshoots are generally not included in documentations or they lack details [18]. Though, as we saw, including troubleshoots and attempts that did not work is a way to reflect on one's progress: When a problem occurs, makers are focused on how to solve it, resulting in a lack of details and visual support capturing these problems and the explored solutions [18]. It is thus important to encourage the capture of visual support and their context during the activity to avoid missing important information later. In addition to forgetting to document, makers have to overcome barriers when they want to document. Among the most cited reasons in the literature, we find that sometimes makerspaces are poorly equipped with capture devices [22] or missing good quality devices so that makers end up using their own smartphones, but these tend to be forgotten

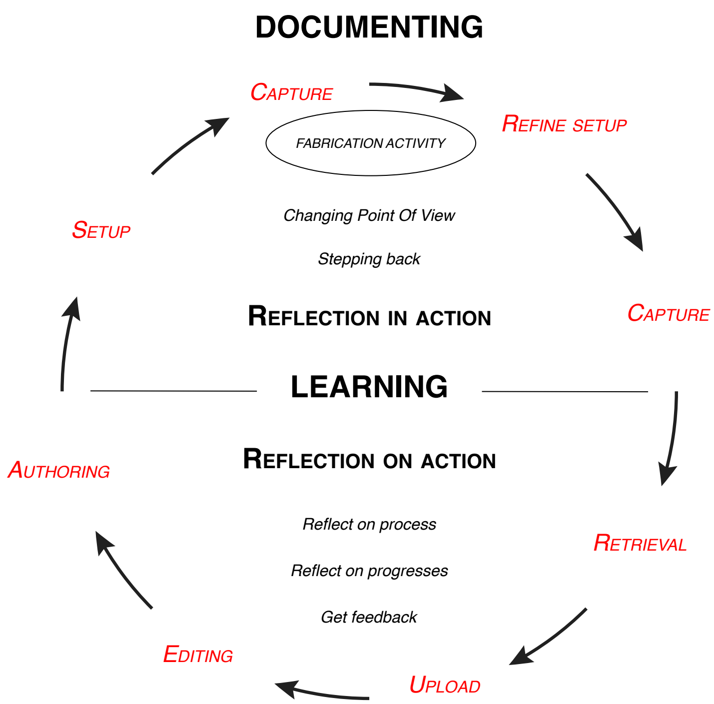

Fig. 1. Documenting is a cyclic operation that we can separate in two moments: during the fabrication activity (top half) and after the fabrication activity (bottom half). The outer circle illustrates the different steps involved in documentation, the keywords in the center recall the respective main aims of documentation in a learning context

and are difficult to use during an activity where hand manipulations are required [15] or need to be used with tripods. Setting up a scene by installing a tripod and adapting the focus and lightning can be cumbersome, especially when the makerspace is not well equipped. This step of capture is followed by a number of intermediary tasks in order to author then share the document (see Figure 1). Makers need to retrieve and transfer the content from the capture device to their computer, curate the content, organize, edit the images or videos, to finally integrate it alongside text in their document, requiring extra time, effort and special skills [28]. All these steps make it difficult to immediately retrieve the content and display it without dedicated tools, however this is crucial to support reflection during an activity [8, 12].

To sum up, documenting is easily forgotten and exposed to barriers at different levels: setting up a scene can be cumbersome, uploading then retrieving the content is time consuming as well as processing, editing then authoring a final document.

1.3 Systems to support documenting in learning contexts

Supporting documentation practices in the context of learning involves encouraging to capture traces while limiting the obstacles. One popular way to encourage the capture of traces are *documentation stations*, installations including a mounted camera located in a dedicated place, reinforcing the propensity to think about documenting and providing nice angles to capture visual evidences. Three examples of such stations are the ones of Dodoc [12], Protobooth [3] and DIY Documentation stations described by Keune et al. [15]. DoDoc [12] is a station on which capture devices and lights can be attached at different positions. The content is directly displayed on a screen to support reflection—*IN*—action and uploaded on the maker's personal repository. In a similar way, Protobooth [3] includes multiple cameras to capture different point of views of an object, but compared to DoDoc, does not provide the possibility of adapting their positioning according to one's needs, neither provides direct feedback of what is being captured. The content captured with Protobooth is automatically uploaded to a website as entries that makers can edit later on. One main issue with both of these stations are that they are constrained to one location whereas making is an activity that generally requires moving between different spaces [2]. Keune et al. [15] describe DIY methods to create low cost structures to mount smartphones and tablets, and create easily transportable stations. These DIY methods however do not allow for easily changing view angles unless one builds one station by view angle. Furthermore, this approach is based on smartphones and tablets and does not provide solutions to reduce the upload-retrieval-edit-share difficulties.

Apart from documentation stations, dedicated applications can support documenting in a learning context. Document-While-Doing [20] is a mobile application that enables to take pictures and record sound annotations that end up in a project repository. Each project is associated with a web-page automatically generated, similarly to Protobooth [3]. Furthermore, the application provides a tool to automatically reduce the size of the images to be included in the web-page. Finally, tools such as Build-In-Progress [26], Protobooth Oulu [1] provide software solution to support feedback during the project.

The tools presented here are a selection of approaches to support documenting in a learning context. Documentation stations encourage the capture of content during the activity to favor reflection—*IN*—action and avoid missing important steps and failures. Other systems support feedback alongside the project and some help makers with processing. We can see that some of these already introduce automation, as they provide automated upload and categorization of the content [1, 3, 12, 20], automated image-processing [20] and some even pre-creates entries in the documentation [3, 20]. If these approaches are already promising, it seems that more can be done to support makers in documenting.

2 HOW MUCH AUTOMATION DO WE ~~WANT~~NEED?

As we saw, documenting is an important activity in makerspaces and especially in a learning context. This task requires effort from the maker at different levels, and part of this effort is necessary, for instance choosing the good moment to capture content or curating and annotating as a mean to reflect on the past activity. However, some of these efforts such as setting up the capture device, uploading from one device to a computer, do not seem to provide any benefit for the maker and rather are interfering with their workflow. We saw in subsection 1.3 that some of the systems that are designed to support learners already introduce automation, which do not conflict with the pedagogical benefits of documenting. In this section we wonder if more could be automated, based on our own reflections and on what has been done in the context of tutorials. We first consider the scale of the project, when documenting serves as a support for reflection on the process: Reflection—*ON*—Action, then we focus on the moment of the fabrication activity itself, when documenting allows the maker to step back and get an overview of what they are doing: Reflection—*IN*—Action.

2.1 Reflection—*ON*—Action VS Automation

One strategy to make the documentation easier for makers working in groups is to dedicate one member to the task [8], but what if the maker is working alone? We can imagine that a system could take care of the documentation and leaving the maker to their fabrication activity. In the context of tutorials, several systems automate creation of the complete document by automatically recording author's events [6, 10, 13, 17] on a computer based activity, or in the case of fabrication activities such as assembly tasks [5, 27] and augmented reality tutorials. The latter implies to automate tracking of the location and position of the objects the maker interacts with by using Optitrack [29], tools recognition [7], or hand-tracking [9]. These techniques are difficult to generalize though since they are constrained to a known environment and known objects, but the advances in computer vision and the availability of machine learning in object recognition could make the automated identification of objects, materials and tools more available in future years.

Thus, it might be possible to automate the whole documenting process, however, does it keep the benefits of documenting to support learning? Part of the documenting process implies that the maker takes a narrative approach, by considering the rationale, troubleshoots, things that worked or not, and to integrate a **reflection on their own processes and progress**. By automating the whole creation of documentation, this reflection would probably be impossible, and a distant feeling from the final document might even lead the maker to not even interact with it at all. It could be thus interesting to investigate how full automation can still fulfill the needs for learners by studying how interaction with the automated process can be supported, to maintain reflection on the current progress based on this documentation.

Another way to use automation could be not to automate everything, but instead to automate things that do not matter for learners and that we consider as obstructions to the workflow. Indeed, it seems that a parsimonious automation in documentation creation, such as processing images and pre-creating entries in a documentation that can later-on be enriched by the maker [3, 20], can be a way to facilitate the work of the maker while preserving the opportunity for learning. More generally, what we can tell from the systems for documentation in learning that we mentioned in subsection 1.3, is that there are advantages in having a central system covering the capture and storage of content, as it enables automated upload of the content captured. Automated upload from the capture device to the one where the documentation is authored, saves considerable time and effort to the maker [19, 22] who would instead focus on more important things. Automation can thus help makers on the difficult and time consuming steps between content capture and authoring the documentation so they can focus on what matter at these moments: **Reflecting—*On*—Action**. These steps are posteriors to the activity in the makerspace which is the moment exposed to most important barriers, we now investigate how automation could support the makers in documenting during the fabrication activity.

2.2 Reflection—*IN*—Action VS Automation

We saw earlier that during the activity, documenting is important to give opportunity to the maker to step back and Reflect—*IN*—Action. This step involves mainly capturing visual content such as pictures and videos, annotations or sketches. This is also the moment that leads to the most conflicts between the fabrication activity and the documenting task. The maker needs to install and setup the device while working and to think about capturing all the important details that they will need later on.

Automating the capture of the visual content is probably not suitable in any context as it first leads to a large amount of—useless—data that needs to be stored and curated. Furthermore, automated capture of visual support material does not provide the opportunity for **reflecting during the activity** as the maker will not stop their activity and step back from it. The makers must be the one to decide the right moment to trigger the capture of images or videos [15].

A parade for automated data-collection could thus be to let the trigger of the visual content to the maker but automate the capture of extra content to keep the benefits of **stepping back** and **reflecting** while saving effort to the maker. It could even be a means to support **better narratives** since more information about the past activity would be made available to the maker to recall, as well as help instructors better understand the actions of the learner.

Finally, in order to capture makers have to setup and refine the setup of their capture device during their activity. This task is cumbersome for the makers who needs to take time to find the proper capture device, install it, adapt the focus and the orientation and positions of the camera in order to capture their process or object. This time could be dedicated to their learning instead. Automating the control of the orientation and position of the camera could as well be an opportunity in the case of remote learning, where teacher sometimes struggle to follow the activity of learners [16]. Therefore, there might be interesting paths to explore on automated camera movements and displacements to support **Reflection—*IN*—Action** and help remote instructors.

3 CONCLUSION

In this position paper, we saw that many aspects of documentations are candidates to automation, we also saw that others aspects should most definitely be handled by the learner. Parsimonious automation is promising for documenting and creating tutorials but in the case of learning, additional dimensions need to be considered. In addition, the specific case of learning might raise other barriers related to technology in a school environment [25].

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