Tutorial Authorship and Hybrid Designers: The Joy (and Frustration) of DIY Tutorials

Ron Wakkary[1,2], Markus Lorenz Schilling[1], Matthew A. Dalton[1], Sabrina Hauser[1], Audrey Desjardins[1], Xiao Zhang[1], Henry W.J. Lin[1]
[1] Simon Fraser University, Surrey, British Columbia, Canada
[2] Eindhoven University of Technology, Eindhoven, Netherlands
{rwakkary, mschilli, mdalton, shauser, adesjard, xza57, hwlin}@sfu.ca

ABSTRACT
Tutorials are critical to the success and vitality of DIY practices. In this paper, we elevate the importance of tutorial authorship as one way to maintain and improve the quality of tutorials in DIY. We discuss the role interaction designers can play as *hybrid designers,* mediating between author and audience to contribute to the improvement of practices of tutorial authorship in DIY. We examine the quality of tutorials through the building and analysis of ten DIY projects and tutorials. We analyze key issues across three categories: 1) competences, components and tools, 2) sequencing, 3) and communication. We offer findings that are both practical guidelines for detailed improvements of tutorials and structural themes for improving tutorial authorship including the themes of *accurate information*, *competences and tools*, and *tutorial format*. In conclusion, we discuss the potential for interaction designers to simultaneously mediate and shape tutorials and tools in a form of hybrid design.

Author Keywords
DIY; Tutorials; Interaction Design; Making Culture; Authorship; Hybrid Designer.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The emergence of Do-it-yourself (DIY) practices has disrupted how we produce and who produces designed artifacts and technologies. At the center of DIY practices are the decentralization of design and production and the wide scale empowerment of amateurs and hobbyists to become designers and producers. Key to this paradigmatic shift of empowering a new class of producers is the learning and sharing of DIY projects through the means of online tutorials. Tutorials explain the components, tools, and processes required to make DIY projects. The practice of writing and sharing DIY tutorials is at the heart of the distributed production and creativity of DIY. Tutorials not only provide tutorship of particular projects, they also develop the skills and competences of those involved in DIY and, in doing so, expand the culture and practices of DIY. It is fair to say that the vitality of DIY practices relies on the effectiveness and quality of tutorials. Additionally, we see a role for interaction designers to help improve upon the practice of tutorials in DIY. Hence, in this paper, we ask two questions: 1) What is the quality of a typical DIY tutorial? 2) What role can interaction designers play in supporting and enhancing the quality of tutorials in the practices of DIY?

With the first question in mind, we set out to examine tutorials of DIY projects. We created a sample of ten projects from a variety of known DIY sources. With a systematic process of analysis, we attempted to make each of the projects following the instructions of the tutorials. In this paper, we report on our findings that examined tutorials across three categories: 1) competences, components and tools, 2) sequencing, 3) and communication. In our findings, we provide practical guidance to improve tutorials and describe the key issues organized under the themes of accurate information, competences and tools, and tutorial format.

To answer the second question, we critically explore the current and past practices of DIY tutorial authorship. We begin with a review of relevant past practices in tutorials including print DIY, the Whole Earth Catalog, cookbook practices, and Braun's Lectron kit. This inspired us together with findings from our study to propose that interaction designers can constructively influence DIY practices as a *hybrid designer*. In the context of DIY, hybrid design mediates through design the role of tutorial authors and the audiences. The idea of designing resources to support everyday practices like DIY is influenced by theories of social practice [16]. In a separate paper [22], we discuss the relations of social practices and interaction design more fully as "practice-oriented" design that includes the idea of a hybrid designer.

We begin the paper with a discussion of tutorials and technical writing. This is followed by a review of literature

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in HCI related to DIY practices. We then review practices of tutorial authorship as a last part of related works. Following that, we present our study and data analysis examining the quality of DIY. We conclude with practical guidelines and by emphasizing the importance of tutorial authorship. This leads to our central argument that interaction design can support DIY practices in a form of hybrid design that simultaneously mediates matters of and shapes tutorials and tools.

Our approach in this paper is both empirical and analytical. We encapsulate an auto-ethnographic study within a critical argument. The argument begins with the antecedents to DIY that reveal the importance of tutorials to a practice but especially how designers can positively shape DIY practices. The argument continues with an analytical reading of the study findings of DIY tutorial to link these to our discussion of antecedents. The critical argument concludes by drawing on the analysis of historical antecedents and study findings to make the claim of a hybrid design role for interaction designers.

TUTORIALS AND TECHNICAL WRITING

Today, with developments in information technology, the Internet, help systems, and distance learning, tutorials have reached an unprecedented level of popularity [7,13]. This change fostered more self-directed tutorials rather than the interactive facilitation of traditional in-person tutorials [1]. In DIY, the self-directed nature of online tutorials can make it a challenge to balance independent learning with detailed and responsive guidance. However in our study we found a related but more pressing issue to be increasing the quality of DIY tutorials.

Technical writing can be described as a style of writing that allows any user to read and clearly understand a textual and/or visual medium that informs the reader about a technology, service or product regardless of his knowledge. Technical writing needs to fulfill several requirements like accuracy, understandability, and accessibility [8]. The Society for Technical Communication (STC) originating in 1953, is the oldest professional association for technical communication and reaches across every industry and continent (see http://www.stc.org). However, despite this longstanding professional discipline, there is virtually no interaction between DIY practices and the professional practices of technical writing. While the quality of DIY tutorials would benefit from the expertise of technical writing it is typical of an everyday practice like DIY to see itself as distinct if not in contradiction to professional organizations and practices and thus not seek professional input [6].

DIY and HCI

In the past years, the HCI field has shown increasing interest in DIY communities and practices. Buechley et al. held a seminal workshop at CHI 2009 [3]. The discussions ranged from practical aspects such as the tools and materials to the broader political, economic, and social implications of DIY practices. Some of these broader issues have been taken up by researchers to provide more insights into the impact of DIY communities and practices. Some researchers argue DIY communities exemplify alternative ways to engage with everyday objects and technologies [2]. Relatedly, others argue that DIY practitioners aim to fit DIY to their own cultural identity [17]. Lindtner et al. [10] found DIY practices are evolving and transformative, becoming new forms of industrial innovation and manufacture that extended these practices beyond hobbies.

Related to our focus on tutorials, researchers have also worked at creating guidelines and tools to support them. For example, De Roeck et al. [14] provided thirteen design rubrics to help designers envision and design systems that enable people to program computers more easily. One strand of research on DIY practices has focused on craft knowledge creation, communication, and consumption. Torrey et al. [19] observed the engagement of electronics and computer hobbyists in the generating process of online How-to pages. They presented this process in three stages: the *project* (making the project itself), the *story* (documenting the story of making), and the *contribution* (broadcasting the How-To). They argued that, at each step, the nature of the work conducted by the hobbyists changed and that a translation process took place from the physical actions to the written and visual instructions. Torrey et al. [18] also explored the online knowledge seeking strategies among crafters and presented the limitations of utilizing these strategies. Kuznetsov and Paulos [9] investigated the motivations and means of DIY amateurs participating in and contributing to online knowledge sharing. Tseng and Resnick [20] examined the challenges project authors encounter when documenting a DIY project and the varied ways in which these authors translated their documentations into “a sharable format” [p.425]. Dalton et al. [5] presented an experimentation of transforming two existing DIY tutorials into a cookbook recipe format. They argued that the maturation process of cookbooks is a good reference for the evolution of DIY tutorials, particularly with regard to formatting tutorials. Together, this research demonstrates that the open sharing of knowledge is an important element of DIY culture and embodies a vital value of DIY practices. However, we see a gap in the research investigating the quality of DIY tutorials, which we argue is the basis for successful knowledge transfer.

Our work is different from this previous research in the sense that instead of exploring DIY practices through looking at what DIY enthusiasts do, we examine what makes up a quality DIY tutorial by *acting the role* of enthusiasts—following the existing DIY projects’ instructions to recreate the projects—and directly experiencing the challenges and issues. Further, we aim to critically suggest a practice-oriented role for interaction designers as hybrid designers to support DIY practices.

PRACTICES OF TUTORIAL AUTHORSHIP

We present in this section related previous practices of DIY tutorials to help establish the importance of tutorial authorship and initiate our argument that links historical relations between design and early DIY as means to improve DIY practices. We explore print DIY, namely the Whole Earth Catalog, the practice of cookbooks, and Braun's Lectron. We later draw on these antecedents and incorporate them in our discussion of findings.

Print DIY and the Whole Earth Catalog

The era of printed DIY or instructional tutorials are key antecedents to current DIY practices. From the earliest DIY instructional tutorials in Popular Mechanics to the rise of car repair and especially home renovations that remains very popular, print DIY had evolved into a strong practice. The boom in the 1970s of early DIY can in large part be attributed to Stewart Brand's Whole Earth Catalog, which was founded in 1968 and represented the convergence of counter-culture and systems thinking [12,21].

The Whole Earth Catalog, as mentioned above, was a watershed moment in print DIY, that in ethos holds much in common with today's DIY movement. Founder Stewart Brand saw in print the power to bring together "counterculture communities, back-to-the-land households, and innovators in the fields of technology, design, and architecture" [12] to both foster and celebrate individual creativity and invention in the service of community building (see also [21]).

The relevance of the Whole Earth Catalog to our exploration is that it demonstrates that tutorial authorship goes well beyond the goal of instruction toward caring for and guiding a practice that has implications that can lead to far reaching change. The Whole Earth Catalog and Brand can be seen as an early example of a hybrid design in DIY. Brand in most cases did not author the tutorials but formatted and produced them in the Whole Earth Catalog. He was careful to lead and cultivate credibility through the communication and dissemination of quality tutorials [23].

Cookbooks

We see cookbooks as another form of instructional genre that contributes to the idea of tutorial authorship. The evolution of the modern cookbook began with the communication of the competences and skills of the professional cook only to later give way to cookbooks that positioned themselves as a dialogue and exchange between homemakers and amateur cooks. This gave rise to the importance of the cookbook author over or equal to the professional chef. The practice of amateur cooking relied more on the skills of a good tutorial author than a skilled chef who cannot share their knowledge. Commensurate with the rise of the tutorial author, cookbooks evolved to consider instructions that addressed building on the competences of the amateur cook, clear and precise formatting of recipes, and local translations in sourcing ingredients.

For example, the first classical modern cookbook, *Mastering the Art of French Cooking* [4] by classically trained Julia Child and co-authors, devoted attention to making the traditions of French cooking accessible to the American market by translating the ingredients list to those that can be sourced at the American grocery stores and to train a largely untrained audience in the basic skills and techniques of professional cooking. The competences development included tutorials on basic skills like cutting vegetables, necessary kitchen tools, and basic but essential knowledge of wines [4]. Erica Rombauer, an amateur cook and author of the most successful commercial cookbook, *Joy of Cooking* [15], similarly translated skills and knowhow to her fellow amateur cooks. Most importantly, Rombauer progressed the format and tone for cookbook instruction that became normalized to ensure brevity, clarity, accuracy, and adequate preparation and timing.

Popular cookbook authors like Nigella Lawson and online bloggers like Deb Perelman (http://smittenkitchen.com) are more known as authors and food enthusiasts then professionally trained chefs, which they are not. Rombauer's background as an amateur opened cookbook authoring to amateur experts and peer-to-peer sharing, which relates back to the essentials of DIY tutorials.

Braun's Lectron

An early example of how design abilities and knowledge can better support learning is Lectron, a system and toolkit for experimenting with and learning about electricity. Lectron was invented in 1966 by Georg Franz Greger and directed towards younger hobbyists but initially had little success. In 1967, Braun bought Lectron, recognizing the systems potential to play a significant role in teaching electronics. A significant contribution to the subsequent success of Lectron as an educational system came from the Braun design team under the lead of Dieter Rams. They not only re-designed the packaging but also invented new models (see figure 1). A bestselling model called Buchlabor (translates to booklab) included an award winning instruction book, which was translated in multiple languages (see http://www.lectron.info). Through the design efforts to support the new direction, the product became a national and international success and reached a wider audience including a young Massimo Banzi (founder of Arduino) who shared his experience with Lectron:

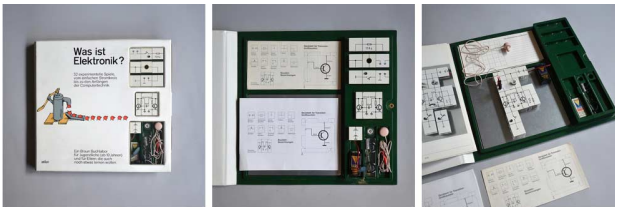


Figure 1 Lectron, a teaching tool to experiment with and learn about electronics.

This is the "toy" I used to learn electronics when I was a kid. It had a huge impact on me as it made me interested in electronics and design. The manual that came with it also influenced the way I teach [11].

The example of Lectron shows how design can positively shape a learning system and support its educational intent. Translating complex structures into simple, concrete, easy to follow entities are critical skills and part of the benefits of design that can also serve to improve DIY tutorials.

The aim of this section is to begin our argument for how designers can positively support DIY practices by revealing the relationship between design and prior tutorial authorship practices. We will return to this critical argumentation by drawing it into our discussion of findings. However, next we shift to the empirical study that links past practices to current practices and issues in DIY tutorials. In the following section we report on the methods and findings of our study of building ten DIY projects.

OUR STUDY

Aiming to examine the quality of DIY tutorials, we put ourselves in the position of DIY enthusiasts, attempting to build ten DIY projects by following their tutorials. We documented this process and analyzed our experiences and observations. In the context of our study, we believe that the process of following the tutorials ourselves is a straightforward way to investigate the challenges and opportunities of DIY instructions.

Selection

We carefully selected our sample of DIY project tutorials making sure they were from different sources and of various difficulty levels, required a variety of technical expertise, and used different instructional formats such as video, text, and text/image combinations. In order to cover a range of skills and competences involved, we previously categorized twenty-two DIY projects into three difficulty levels - easy, medium, and hard - based on our experiences. We further reduced this to ten projects covering each difficulty levels (see table 1) based on which projects were new to researchers and those they were most interested in making. If we happened to come across a tutorial with an existing rating scale (for example the Wii Nunchuck Mouse) we found that our assessment coincided with the tutorials prescribed difficulty.

We used various criteria such as user reviews and online expert selection to confirm our tutorials were tested and accepted within the DIY communities. Some of our chosen sources such as Instructables (http://instructables.com) and Thingiverse (http://thingiverse.com) are a repository for tutorials from individuals around the world. Both have internal user rating systems, as well as systems that allow staff to feature quality tutorials. In these cases, we chose highly rated or featured tutorials. We further chose tutorials from Make Magazine (http://makezine.com), a quarterly magazine that handpicks, edits, and presents DIY tutorials to the public; from Fattelo (http://fattelo.com), an Italian design company whose DIY project was featured by many design blogs and websites; and from Jdeboi (http://jdeboi.com), a personal website of Jenna deBoisblanc, whose tutorial was featured on several well-known blogs including Lifehacker (http://lifehacker.com), TreeHugger (http://treehugger.com), Bike Hugger (http://bikehugger.com), and Adafruit (http://adafruit.com). Furthermore, we chose a tutorial released by MIT Media Labs High-Low Tech department, featured on several tech blogs including Boing Boing (http://boingboing.net) and Hackedgadgets (http://hackedgadgets.com) that was made into a featured tutorial on Instructables by the original author. We also included two tutorial kits, which are fully assembled and packaged projects that come with all of the materials, components, and instructions. We chose the TV-B-Gone kit tutorial from Mitch Altman (Cornfield Electronics (http://cornfieldelectronics.com), which has

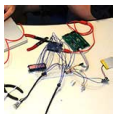
Cardboard Desk Lamp	Gear O'Clock	TV-B-Gone Kit	Wii Nunchuk Mouse	Biped Walking Robot Kit	pimpMyBike	Sleek Word Clock	Solar Shrub	DIY Cellphone	Google Play Radio
									
Fattelo	Thingiverse	Cornfield Electronics	Make Magazine	Gakken	Jenna deBoisblanc	Instructables	Instructables	MIT Media Labs	Instructables
Computer desk lamp built out of cardboard	3D Printed mechanical clock using two gears	Universal remote to turn off and on almost any TV	Control your mouse cursor with a Wii Nunchuck	Mechanical robot that walks toward a wind source	Bike light system built with an Arduino	A clock that tells the time by highlight-ing words	Solar Plant to charge your electronic device via USB	Cellphone built from electronic components	Streaming radio built around a Raspberry Pi
Easy	Easy	Easy	Easy	Medium	Medium	Medium	Meduim	Hard	Hard

Table 1 List of projects, including their source, description and level of difficulty (Photos by Henry Lin)

Figure 2 Still from time-lapse documentation of the Solar Shrub build

been revised several times and a kit from Gakken (http://ghd.gakken.co.jp/english), a Japanese company whose educational kits are widely popular.

Our Technical Backgrounds

Six members of our design research studio were involved in completing the tutorials. Our competences, tools and building environment were more than sufficient to complete the selected projects with adequate instructions. We identify ourselves as DIY enthusiasts, with different degrees of involvement in the community. Personal projects from the members of our design studio include making a CNC machine, renovating a house, converting a van into a camper, making simple electronic devices and more. Each member brings a unique skill set including knowledge of working with electronics, reading schematics, soldering, or building skills. In addition, our studio has a wide range of equipment and tools including soldering irons, multimeters, a 3D printer, and a laser cutter.

Build and Process Documentation

All tutorial builds were conducted by a minimum of the same two researchers from our group. During each build, one of them took charge of building, while the other one took charge of observation and documentation. Other builders alternated among the builds. This system ensured we had two separate individuals who could provide a frame of reference across all tutorials for how well or poorly written individual steps or entire tutorials were written. The other four participants provided help in building, data gathering and analysis. Whilst building, we annotated tutorials and a stationary camera was set up to take pictures every five seconds of the build, which allowed us to create a time-lapse video of every project build (See figure 2). These images, videos, and annotations helped us analyze the building process further.

Study Data

Attempting to build the chosen ten projects, we ended up with different outcomes. Despite challenges with instructions, some projects were finished within a short period of time, whereas other projects were complicated and overly time consuming due to the complexity of the builds and poor instructions. Some projects were impossible to follow or complete based on the tutorials. While we were able to build all of the easy projects, one medium and one hard project were not completed.

After the build, we catalogued several elements of the tutorial's quality in a spreadsheet including but not limited to sequences, procedures, materials, tools, skills, preparation, sourcing of materials, costs, text/images, and outcome. We began our analysis by discussing each project individually, in terms of the positive and negative aspects of the different catalogued elements. Following that, we created a higher-level thematic analysis combining data from all projects, which we ultimately organized across three categories: 1) competences, components and tools; 2) sequencing, 3) and communication. In what immediately follows, we present this analysis from our examination of DIY tutorials in detail.

ANALYSIS

There are different aspects to following a tutorial and these aspects are largely interdependent. In our analysis, we broke this process down into three categories: 1) competences, components and tools, 2) sequencing, 3) and communication. Note that these categories are not mutually exclusive. We should mention that we encountered various issues in sourcing components; however, we have omitted those findings for reasons of space and to focus specifically on the content and form of tutorials.

Additionally, the issue of accuracy affects all aspects of the tutorial and can be considered as an orthogonal concern to our three categories. More specifically, a tutorial that communicates false information albeit well is still flawed. It is a fundamental value of DIY tutorials to pass on accurate knowledge and know-how on a specific project. In our analysis, we made the assumption (like others relying on tutorials) that the knowledge communicated in our sample tutorials would be accurate and credible. However, many, if not all, tutorials fell short in accuracy. This happened most commonly through omission or leaving out details, which often led to confusion or errors. For example, in the instructions for the Sleek Word Clock the author does not describe which sets of LED strings need to be soldered onto a single male pin header. This determines which LEDs and therefore which words are displayed to show the correct time. In another critical flaw, a missing detail led to our failed build of the Gear O'Clock. The instructions do not mention to glue the numbers for the clock counter-clockwise onto the outer gear. Attaching the numbers clockwise onto the outer gear (what we did) resulted in our clock's display running in the reverse direction – counter-clockwise.

Competences, Components and Tools

The required competences, components, and tools to successfully complete a tutorial are a complex interrelated

set of issues unto themselves. A tool is only as useful as the builder's competences to use it properly, which will lead to the successful or failed integration of components. For example, a component that requires soldering to a circuit board necessitates a soldering iron and the appropriate skills. The challenge for any tutorial is that a breakdown, omission, or inaccuracy anywhere along this chain can lead to confusion or an error. Adding to the challenge, the required and available tools and competences of the builder can be difficult to predict and fully understand.

Our tutorials were inconsistent and unclear on how to present the related aspects of competences, components, and tools. Each tried various strategies from listing materials and tools separately to embedding the information throughout the tutorial.

Common issues with our tutorials were that information on tools and components were difficult to find in the tutorials, and necessary tools and materials were often omitted. These issues compounded each other depending on the format the tutorial authors used. For example, information on tools and competences that were embedded in the sequence of the tutorial were easy to find at the relevant step but difficult to find at the outset during preparation for a build. This was the case with the Sleek Word Clock. In other instances, components and tools were presented as a list at the beginning of the tutorial, however in these cases when a particular step was confusing it could be difficult to determine if this was due to an omission or to the inaccuracy in the components and tools list. Yet, this approach allowed for adequate preparation at the outset of the build, if the lists were accurate.

Beyond components and tools, competences are a more challenging aspect of DIY tutorials. In essence, it is a matter of authors targeting a project at a particular skill and knowledge level of the builder. However, anticipating a level of expertise can be difficult and it is a challenge to assume what competences constitute a level of expertise, especially since our DIY builds required a wide range of skills and knowledge from crafts to electronics. For example, a builder can have advanced electronics skills but little knowledge of physical construction.

A small minority of our tutorials explicitly stated the expected skill level of a potential builder like the Wii Nunchuck Mouse; the majority of our tutorials did not. Yet, existing competences of a builder are inevitably assumed, which is not without problems. Especially, two of our tutorials stretched the presumptions of builder competences too far. In pimpMyBike, the expectation of the tutorial was that builders could pull together discrete builds into a complete project but the gaps between the builds were simply too great for us and we were not able to complete the project. With the Google Play Internet Radio, the author states that the components list is incomplete since it is difficult to manage a list of parts for a project of this complexity. The tutorial restricts itself to listing the six most important components with the expectation that the builder has the competence to determine the necessary missing components and how to integrate these. Despite our advanced competences, we were not able to build this project.

An additional strategy to address competences are tutorials that aim to complement existing skills and know-how of a potential builder with explicit guidance on specialized skills or learning new competences in order to complete the project. Despite the challenges of the pimpMyBike tutorial, it was successful at providing links to other tutorials on specific skills and knowledge needed such as soldering. In another example, the DIY Cellphone required having circuit boards printed by a fabrication service. The author provided the reader with several online companies to print circuit boards. He also explained how the builder could ensure that they receive a properly printed circuit board from the service. In this case, when required competences were too high, the author provided clear alternatives to overcome the challenge.

Sequencing

Sequencing refers to the completion of tasks within a tutorial in the right order. We expected tutorials to be successful at this since essentially, tutorials tell a story of how to build something from beginning to end, and the tutorials in our study generally were. In one particular case, the TV-B-Gone, the authors took the additional effort to organize the tutorial into sections of sub-tasks that made managing the process simpler. For example, the tutorial was separated into nine sections including an overview, F.A.Q, Make It, Testing, Using, Design Notes, Download, Buy Kit, and Forums. When required, individual sections were very detailed. The section 'Make It' for instance had three sub-sections: for preparation, for the parts list, and for soldering.

However, we also found several sequencing issues within our tutorials. These included large gaps between single tasks, tasks that describe too much information at once, and tasks that require information external to the tutorial. For example, in the Google Play Radio, the gaps between the tasks were too large to bridge without more information. This created a sequence that failed to clearly link a current task to actions of the next or previous tasks. Independent tasks were accurate but it was very challenging to see how steps were interrelated and how progress was made towards the whole build.

The instructions for the Biped Walking Robot included too much information within a description of a single task. The tutorial utilizes graphics and pictures to show a snapshot of the current build with an illustration at each step or task. This is a helpful idea yet the builder is required to attach too many parts within a single step such that the mapping of the sequence to the illustrations becomes difficult to follow.

In the section on Competences, Components and Tools, we referred to the pimpMyBike as a good example of complementing anticipated competences of the builder with new competences through linking to other tutorials.

Conceptually this is a good idea; however, in this case the tutorial often linked too many supplementary videos for the number of tasks. Moreover, the greater issue was that the external tutorials delivered information and know-how in a different style, with different terminology, and within a different context or even project. This disrupted the sequencing of the tutorial making for a fragmented and cumbersome process.

Communication

The communication of a project refers to the use of text, images, and videos in the tutorial. We previously discussed the difficulties of inconsistent video presentation in the tutorial for the pimpMyBike (see Sequencing). In addition to poor video consistency, poorly displayed text can be difficult to follow. For example, the tutorial for the Gear O'Clock is exclusively text. Aside from an online gallery of finished builds there are no images to help with instruction. The build process for this particular project is very spatial, requiring 3D printed parts, and assembly and manipulation of clock mechanisms. Illustrations would definitely help visualize the required tasks.

While mostly helpful, when used poorly, images can make following tutorials difficult. For example, the images in the tutorial for the Solar Shrub are well photographed but the inconsistent orientation and lack of annotations makes it difficult to understand the purpose of the images. In addition, the images need to be in sequence. In the TV-B-Gone, a photo shows parts soldered onto the circuit board despite that step not having yet been completed in the tutorial. This led to confusion and the feeling that we missed a step.

Despite this misstep in the TV-B-Gone tutorial, the tutorial, like others in our sample, managed the proximity of images to textual descriptions of tasks well. In this particular case, two columns and rows were used for formatting so that each step was accompanied by an image in the same row. Annotations and numbering of images can help with communication. For example, the author of the Sleek Word Clock made use of annotations within his instructions and each picture was numbered allowing images to be cited in the text descriptions.

FINDINGS

Based on our analysis we provide practical guidance and identified three themes that highlight in more detail and complexity issues with DIY tutorials: accurate information, competences and tools, and tutorial format. Our practical findings are straightforward recommendations drawn from our analysis:

- Ensure information is accurate;
- Do not omit necessary tools and components;
- Clearly identify necessary tools and components;
- Identify prerequisite and necessary competences;
- Clearly sequence tasks and required information;
- Divide tasks into manageable steps;
- Communicate through texts and images in proximity to each other and relevant tasks;
- Provide quality images with consistent orientation.

Other issues emerged in our study such as considerations of global DIY related to sourcing and the role of localizing tutorial authorship; however, for considerations of space we maintain our focus here on tutorials and tutorial authoring. In what follows, we return to our discussion of past practices of tutorial authorship, presented in previous sections, for improving the current practice of DIY tutorial authorship. Our aim here is to link our study with our larger argument of what role interaction design can play in supporting the practices of DIY. In each theme below we integrate our findings with what we learned from past practices to connect together past and current practices and establish a basis for the argument of supporting future DIY practice through hybrid design.

Accurate information

As we discussed in the analysis, we found that accuracy was an orthogonal issue that covers aspects of competences, components and tools, sequencing, and sourcing. Incomplete or misleading information was part of many of our tutorials. For instance, it happened that all or some tools or components required for a given project were not mentioned in the related tutorial. This inaccuracy often led to confusion, time delays, or failure. From all ten projects, we did not find one tutorial that accurately presented required components, tools, sourcing or sequencing.

Accuracy is a measure of the quality of DIY tutorial practices. Similar to cooking, the practice of authoring cookbooks is as important a practice to peer-to-peer cooking as is cooking itself. Without accurate and accessible DIY tutorials, the practice of DIY would be at risk. In part, the understanding of tutorial authorship as a practice makes explicit the need for accuracy and shifts the factor of credibility to the tutorial author whose success is dependent on consistently producing accurate tutorials. In the antecedent practice of the Whole Earth Catalog, the simple criteria of quality and accuracy were established by the criterion that the catalog ‘be useful as a tool’. This authorial promise needed to be kept. Inaccuracies diminish the quality and usefulness of DIY tutorials and the credibility and success of the tutorial author.

Competences and tools

In building our DIY projects we observed a wide range of tools and competences tutorial authors expected the builders to have. Those expectations varied across the tutorials and were often not explicitly presented. This highlights the gap between the level of competences of the author and the different types of builders that could be interested in any given project. The low barrier to entry to DIY tutorial sites widens the range of skills makers can have when firstly approaching a project [9] . This raised not only the issue of explicitly identifying the intended audience for a project but considering a potential builder’s

capacity to augment and complement existing skills and know-how by learning new abilities. We also raised the problem that competences, components, and tools form a related chain of issues in which a component that requires a complex tool like a laser cutter assumes the competence to operate the tool. In general, we did not see tutorial authors who clearly identified their audience (or multiple audiences) and who fully understood the interrelated nature of competences and tools.

The set of competences, component and tools is a complex matter that needs to make itself more evident as a critical factor in tutorial authorship. A first step is a fuller acknowledgment and explicit addressing of the audience in tutorials. Anticipating competences is a challenge and we are not suggesting that there is one way to address this; in fact, DIY projects with similar ends but a varied range of required competences, components, and tools are what is emerging in the DIY community. The re-alignment of the Lectron product line offers another example of understanding an audience's competences. Braun realized that the system was too expensive to be a children's toy. Parents could hardly afford the system and therefore Braun designed new, cheaper and simpler models to target the toys market but also promoted the more expensive system to vocational schools.

DIY is rooted in an everyday practice such that it is unlikely that basic knowledge and principles would ever make sense to be learned in the abstract. Competences and skills are rarely separated from the project at hand. This is reflected in the fact that sites like Instructables maintain a flat structure with little separation between a tutorial on soldering and tutorials on complex projects. In this sense, it is incumbent on tutorials to take on the role of tutoring competences as well as direct making. As we discussed in the Cookbooks section, early cookbooks used the first chapter to cover a vocabulary of cooking skills that would be referred to later in the recipes. The Whole Earth Catalog established itself as a platform for learning that advocated independent education, meaning the ability to cumulatively develop skills and know-how. This holistic approach fits the view of an ecology of learning in which tutorials are connected to other tutorials and resources.

Format

Our findings show that our tutorials were inconsistent in the quality of their communication and presentation of content. This ranged from poor images, poor text formatting or text intensive tutorials, to linking incompatible videos. In addition, it was not clear if listing components, tools and techniques at the outset of a tutorial in comparison to embedding this information at the step or task required was better, each approach having its own benefits and tradeoffs.

In cooking, format and presentation of recipes evolved as the practice of peer-to-peer home cooking progressed. Arguably, recipes are variations of a simple format that makes them clear and legible. For example, in *The Joy of Cooking* [15], the authors codified the recipe format to follow simple criteria such as clearly identify all necessary ingredients in sequence; explicitly state required techniques in the correct sequence; and specify the outcome in terms of quantity or appearance. For Braun the design and presentation of Lectron was a critical point towards its success.

Summary of findings

In our study and analysis on DIY tutorials, we have discussed detailed issues and problems we encountered and provided practical guidance for improvement of tutorials. We also stressed the importance of tutorial authorship as a practice, providing a structural focus and detailing three themes to improve the practices of DIY. In particular, good practices would address accuracy as a matter of credibility, competences and tools would be at the right level by knowing the audience; and targeting specific audiences and sharing clear formatting criteria would improve communication. We have argued that raising the importance of tutorial authorship will lead to better DIY practices. In the next section, we discuss what role interaction designers can play, and we describe this role as the one of *hybrid designers* who support and enhance the quality of tutorials through the combined expertise of DIY tutorial authorship and design.

DISCUSSION: THE ROLE OF INTERACTION DESIGNERS

While DIY practices exist broadly in the real and virtual worlds, DIY tutorial authorship has largely become an online and computer technology related practice. Given this, interaction design has a critical and significant role in improving tutorial authorship in DIY practices. We see opportunities for interaction design to create better tutorial tools and tutorial generation tools. These tools not only make it easier for authors to create and assemble content but foster better practices of tutorial authoring by the design of good tools. Our practical guidelines can help with considerations for designing tools and as we discussed previously, better tools has been a focus of HCI research in DIY [9,14,19].

However, in addition to a level of technical and design support for DIY practices, in this paper we take the opportunity to build on the structural approach of our findings and articulate a potentially deeper relationship between DIY and interaction design practices in what we term *hybrid design*. The key distinction with hybrid design from typical interaction design is that the outcome of the process is on *resources* for further actions like tutorials rather then finished outcomes like systems or artifacts. A structural relationship between DIY tutorial authorship and interaction design would be built upon essential competences of interaction design practice: the skills and knowledge to design with technology as a medium; the in-depth analytical focus on users of designed systems; and the trained ability to co-design and mediate designs with other experts.

These essential competences would be at the center of a hybrid design approach. As such, a hybrid designer in the context of DIY might focus on tutorials, tools, materials, or processes to mediate between the creator of the content of tutorials and the targeted audience. More specifically, the interaction designer utilizes design to *shape* the content, form, and reception of tutorials. Reception in this sense means the way in which a tutorial is read and utilized which in interaction design terms would foreground interaction. In a hybrid fashion, an interaction designer may work alongside a tutorial author or become an author herself.

Our notion of a hybrid design in the DIY context is inspired by the work of Dieter Rams and Braun on Lectron and Stewart Brand's work on the Whole Earth Catalog. We understand Rams and Brand's contribution as making DIY knowledge widely accessible to many diverse communities – thus becoming translators between two worlds. This emphasis of translation over creation is why we refer to the designer as a hybrid. In addition to Rams and Brand, a contemporary example of a hybrid designer, described by [22], illustrating how a professional designer, Antonio Scarponi from Conceptual Devices, designed a tutorial for an aquaponics system named *Malthus*. Additionnally to sourcing the parts and creating the build process, as a designer Scarponi invested heavily in the tutorial *shaping the content, the form, and the reception.* Notwithstanding that Scarponi is not an interaction designer, it is a good example of how designers can leverage expertise in mediating between practices or domains of knowledge, and in the case of hybrid design produce a resulting form that is the mediation or tutorial and not the outcome or DIY build.

Interaction designers' trained ability to co-design and mediate designs with other experts is essential to being a good hybrid designer. Working with and for the DIY community needs a deep understanding of DIY 'language', practices, tools, materials, and motivations on the one hand and deep design understanding and skills on the other. Not unlike participatory design, the shared matter of concern between designers and DIY enthusiasts, in this case the tutorial, becomes a design situation. Informed by DIY expertise, design is utilized to address the inherent complexities of producing a tutorial. Furthermore, tutorials as a whole become a design opportunity that allows tutorial authors to look beyond the immediate situation to advance the practices of DIY. For example, tutorials can help improve the competences and skill levels of builders.

Interaction designers are trained to apply in-depth analytical attention to users of designed systems. In the context of hybrid design in DIY, keeping attention on the audience of tutorials throughout the design process would vastly improve tutorials. We suggested in our findings that the ability to know the audience would help tutorial authors address complex issues like competences, tools, and communication. Not unlike HCI and learning, we know from experience that interaction designers can design with the relationship between interaction and learning foremost in the designer and tutorial author's minds. Understanding the style of interactions that are beneficial and which competences can best be leveraged is part of knowing the audience in a design sense that would advance the practice of DIY tutorials.

A fundamental quality of an interaction designer is to have the skills and knowledge to design with technology as a medium. Interaction designers understand that in designing with technology, the elements of content, form, interaction, and technology must be an integrated problem and a holistic solution. Given this, we argue that a hybrid designer (on her own or alongside a DIY practitioner) goes beyond designing DIY tools or technologies, to operate at a deeper level in which the creation and designing of a tutorial involves questions of form, technologies, and interaction that incorporate tool making alongside tutorial making. In other words, interaction designers simultaneously generate content and form, or in DIY terms: instructions and instructional media. Arguably there are traces of this approach at the platform level where content and form is integrated in DIY platforms like Instructables, Make: magazine, YouTube, and discussion forums. Yet we see much value in hybrid designers leveraging and progressing this idea at the level of individual authors rather than at the organizational and commercial level that currently exists since DIY is fundamentally a peer-to-peer practice. However this difference between organizational and individual level hybrid design needs further research. Alongside DIY practitioners or on their own, hybrid designers can design tutorials and tutorial tools as a synthesized practice that more fully realizes the potential DIY tutorials and their relations to technologies.

In summary, we discussed how interaction designers in a form of hybrid design can potentially contribute to supporting and enhancing the quality of tutorials and hence DIY practices. A hybrid designer working with or as a DIY practitioner translates between worlds and approaches tutorials as a design situation and tutorial authorship as a design opportunity to advance DIY practices. A hybrid designer leverages interaction design's attention to knowing the audience that would help tutorial authors address complex issues like competences, tools, and communication. Moreover, interaction designers approach tutorials by simultaneously *shaping the content, form, and reception* such that the practice of tutorial authorship integrates the concerns of the tutorial content, technologies, and interaction. We presented examples that inspired us to address the findings of our study, and furthermore, the questions the examples raise point to opportunities for the HCI community to contribute to improving tutorial authorship in DIY practices.

LIMITATIONS

We offer our discussion of interaction designers as hybrid designers as one possibility of many in ways to support DIY practices in a complementary fashion. We are not recommending that interaction designers "take over" DIY

practices nor see that as remotely possible. Rather we offer this as a challenge to HCI, one being grounded in our empirical analytical findings to find ways to learn from and support everyday practices like DIY.

Additionally, we are aware that tutorials are very rarely used in a vacuum and that they are in fact part of an ongoing complex of practices of learning and making; an ecology of learning, that includes a collection of tutorials often addressing similar projects as well as discussions and exchanges between the tutorial author and builders or between builders. Lastly, our study did not include emerging forms of DIY tutorials such as annotated single images as those found on Reddit (reddit.com) and Pinterest (pinterest.com), which may offer a different approach.

CONCLUSION

In conclusion, we analyzed ten DIY projects for the quality and effectiveness of the tutorials. Our findings are organized and presented with respect to accurate information, competences and tools, and tutorial format. This work advances the understanding of DIY tutorials by providing an analysis of the quality of tutorials, guidelines for improvement and raising the importance of DIY tutorial authorship as a practice in its own right. Inspired by Lectron, cooking practices, and the Whole Earth Catalog we see room for interaction designers in the role of hybrid designers to contribute to improving tutorial authorship and DIY.

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