Tutorial: Hot Topics in Personal Fabrication Research

Stefanie Mueller
Hasso Plattner Institute
Potsdam, Germany
stefanie.mueller@hpi.uni-potsdam.de

Alexandra Ion
Hasso Plattner Institute
Potsdam, Germany
alexandra.ion@hpi.uni-potsdam.de

Patrick Baudisch
Hasso Plattner Institute
Potsdam, Germany
patrick.baudisch@hpi.uni-potsdam.de

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Abstract
In this tutorial, we survey novel ways for interacting with personal fabrication machines, such as laser cutters, milling machines, and 3D printers. The goal is to provide attendees with an overview of recent HCI research in personal fabrication and together with attendees build a roadmap for future research directions. Towards this goal, the tutorial will provide background knowledge in how personal fabrication machines work, which types of objects they can fabricate, and how they are currently being operated.

Author Keywords
personal fabrication; rapid prototyping; 3D printing; laser cutting; milling machines.

ACM Classification Keywords
H.5.2

Overview
The recent price drop in personal fabrication tools, such as 3D printers, makes them available to a broader audience [1]. However, the way we are currently interacting with personal fabrication devices still requires a lot of expert knowledge – making it difficult for novice users to use these tools. In this tutorial, we provide an overview of current HCI research that looks into how to facilitate interacting with personal fabrication devices and how to allow for a new range of applications.

Tutorial structure

The tutorial is divided into the following three units:

(1) We start with a short introduction to personal fabrication to provide a shared understanding of what personal fabrication machines are, how they are currently being operated, and what they can fabricate. To make this part of the tutorial also interesting for attendees that are more experienced users of personal fabrication machines, we will add a section on custom 3D printed mechanics and special laser cut joints.

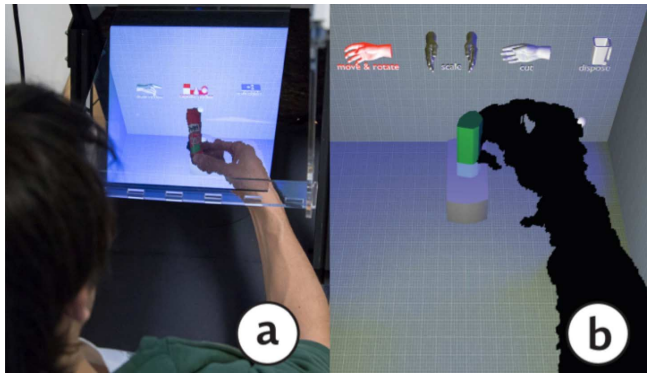

Figure 1. MixFab: mixed-reality editing that allows integrating physical objects into the digital design process.

(2) Based on that shared understanding, we will provide an overview of recent HCI research in personal fabrication. We will first survey the development of moving from solely digital editing (e.g., *SketchChair* [4]), towards mixed-reality environments (e.g., *MixFab* [6]), towards interactive fabrication in which all user input is done on the physical work-piece followed by immediate fabrication [7].

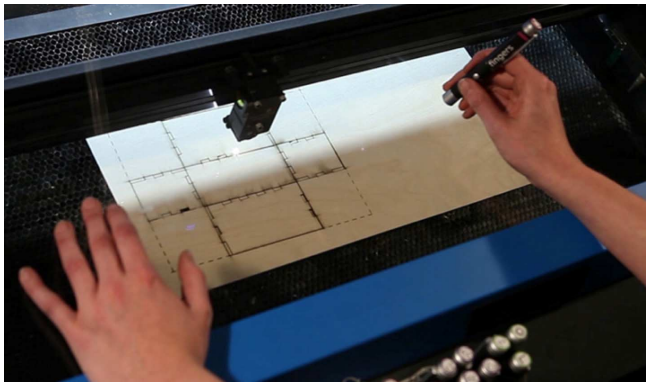

Figure 2. constructable: interactive laser-cutting by drawing directly on the work-piece using hand-held laser-pointers.

We will look into how interactive fabrication can be realized by either using constrained tools (e.g., *constructable* [2]) or by guiding the user based on a pre-selected digital model (e.g., *FreeD* [8]).

Figure 3. FreeD is a hand-held mill that guides the user through fabrication based on a pre-selected digital model.

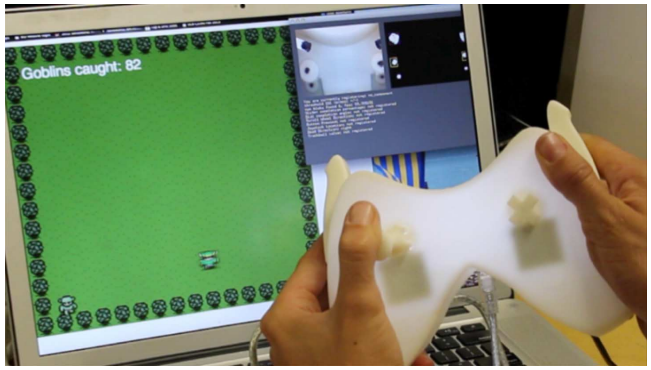

Figure 4. Low-fi prototyping: Sauron uses a single camera to detect user input on a 3D printed object.

Next, we will look at projects that allow for faster design iteration with personal fabrication machines, either by using low-fi prototyping methods in which the prototype itself is low-fidelity (e.g., *Sauron* [5]) or by using the recently introduced concept of low-fi fabrication, in which the 3D model is high-fidelity but fabricated as low-fidelity (e.g., *faBrickation* [2]).

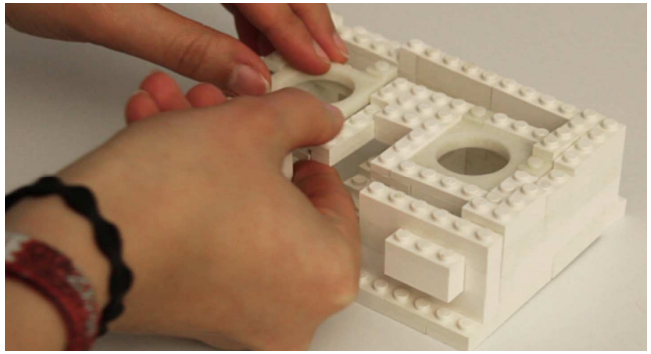

Figure 5. Low-fi fabrication: faBrickator is a system that uses 3D printing for high-detail regions and bricks everywhere else.

Finally, we will look at how personal fabrication allows for the replication of physical objects and how that affects the value of the objects.

(3) In the last part, we will share our thoughts on a future road map for personal fabrication and will open the discussion for possible novel research directions.

Short biography

Stefanie Mueller is a PhD student working with Prof. Patrick Baudisch in the Human Computer Interaction Lab at Hasso Plattner Institute. In her research she develops new types of interfaces for personal fabrication machines that allow for a fast alternation between user input and physical fabrication.

Alexandra Ion is a PhD student working with Prof. Patrick Baudisch in the Human Computer Interaction Lab at Hasso Plattner Institute. Her current research focuses on building wearable devices for haptic feedback and fabricating mechanical appliances.

Patrick Baudisch is a professor in Computer Science at Hasso Plattner Institute at Potsdam University and chair of the Human Computer Interaction Lab. His research focuses on natural user interfaces and interactive devices, including miniature mobile devices, touch input, interactive floors and rooms, and most recently interactive fabrication.

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Additional information

Type: tutorial Length: 4 hours

Physical Requirements: We can bring our own projector and loud speakers for giving the slide deck. We only need a room with one white wall to project on.

Cost of Materials for Participants: We will bring all materials. No extra costs for participants.