Dishmaker: Personal Fabrication Interface

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ABSTRACT
People are tool-makers, but today we often depend on centralized fabrication for our tools. This paper explores the user experience opportunities demonstrated in a case study of a computer-controlled domestic fabrication system. Specifically we explore several approaches to creating a dish-maker that would create dishes on demand under computer control. The Dishmaker can create cups, bowls and plates and recycle them into their raw material when the user is finished eating. A graphic interface allows users to select between cups, bowls or plates that can be created in any volume. This paper describes several working prototypes and shows the approaches for defining your dishes for a meal.

Author Keywords
Tangible computing, Personal Fabrication, Machine Tool, Appliance, Product Design.

ACM Classification Keywords
J.7: Consumer Products.

INTRODUCTION
Rapid prototyping techniques can produce an increasing variety of forms and materials based on 3-dimensional computer models. Personal fabrication could one day produce everything we need locally, replacing the transportation of atoms with the digital transfer of designs. Current personal fabrication are expensive, slow and take considerable attention to use. For making these useful for daily use they should have simple physical and computer interfaces, require less effort than not using them Furthermore, there is little market for *everything* to be manufactured locally, in fact, many of the objects we buy and use have a long useful life. Yet our homes are cluttered with staples that we collect in case they one day serve their purpose. Dishes in the kitchen are one example of an object that actually wastes energy by having a long product life. Aside from the cost of production of infinitely durable plates and bowls, dishes require frequent washing for the duration of their lives – not to mention storage with its associated materials and space. By targeting this specific problem in the kitchen, we are seeking to produce a personal fabrication interface capable reducing the amount of things we live with. The scope of the idea is to obtain new dishes on demand for eating and to be able to recycle them back into the system. The term "dishmaker" was chosen to reflect the potential to replace a large part of what a dishwasher does with a more fundamental recycling effort. The mechanism is called a dishmaker because it produces the useful plates, bowls and cups that can be used for eating. It recycles them so that they can be re-produced for the next meal. By storing the dishes in their raw material, the dishmaker seeks to eliminate clutter as well as to replace storage spaces with productive space.

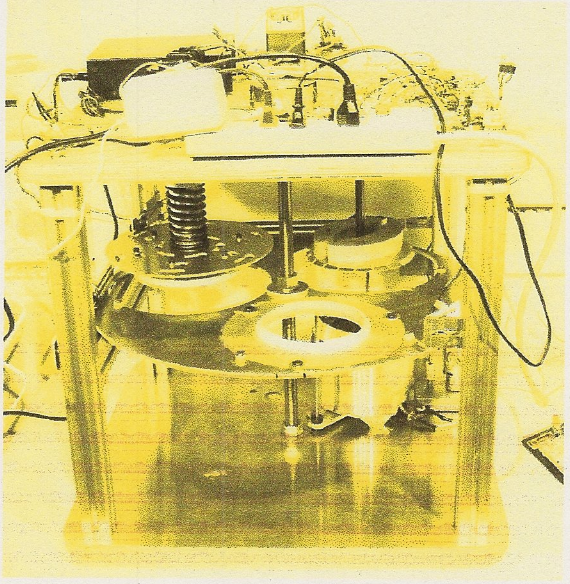

Figure 1. Dish Maker

CHI 2005, April 2-7, 2005, Portland, Oregon, USA.
ACM 1-59593-002-7/05/0004.

RELATED WORK

Today many prototyping laboratories include expensive stereo-lithography, inkjet-stabilization model creation systems and fuse-deposition modeling systems that slowly produce highly detailed models from computer instructions. The idea of rapid prototyping has led to a number of different products already affordable by research laboratories and educational institutions. These employ sophisticated modeling and fabrication to produce accurate, complex forms in small quantities over large periods of time. At the same time, the objects are homogenous lumps of paper, plaster or plastic and require intensive training and post-processing. These objects cannot be recycled locally in the same way that they are produced.

In recent years, the concept of "cradle-to-cradle" manufacturing has been proposed by McDonough and Braungart to describe production design that consider the entire life-cycle of a product. One of the lessons of this theory is that "trash=food:" the end of a product's life should be designed to serve as the beginning of another. This is even more useful if it can be achieved locally, for example if a biodegradable soda bottle contains a flower seed and will actually beautify the landscape when thrown out of an automobile window.

By combining the idea of personal fabrication with the "trash=food" philosophy, we can begin to design appliances that produce consumer goods locally while designed to re-cycle them into new, useful products.

DESIGN

When discussing dream kitchen projects we expressed the desire to throw away dirty dishes after each meal and get new ones for the next. We interpreted her wish as a micro-factory capable of variable production and recycling within the envelope of a conventional dishwasher. Theoretically, such a device could replace part of the cabinets and dishwasher since the material would return to storage in its raw form. The question was whether we could make a variable molding machine capable of producing multiple objects rapidly and recycle them for re-production. Unlike a rapid prototyping machine, this micro-factory would have limited variability but unlimited speed and volume. In addition, it would have to recycle the products indefinitely.

Fortunately, dishes are not as variable in form as typical rapid prototypes. The geometric family of concave, waterproof containers can be produced in a number of ways. Initially, we considered a pottery wheel-approach whereby a robotic arm could throw clay on a robotic pottery wheel. A polymer-clay composite was researched for this purpose, but the need to melt and re-process molten plastic complicated the device into a small injection-molder with high energy consumption. Next we investigated the potential to blow-mold the material, but this alternative required a compressor. Finally, we constructed a machine the size of a dishwasher that can stamp, dispense and recycle plastic pucks into dishes of various sizes with simple components already found in most kitchens: electric motors, heating coils, and micro-switches. Multiple prototypes and proofs-of-concept were involved in the design by a multi-disciplinary team of six mechanical and electrical engineers. A simple interface was developed to "order up" dishes for a meal. Future work will seek to increase the variability and quality of dishes while reducing the energy and time required to make them. Ideally, the dishmaker will become an all-in-one cabinet that contains anything you need, produced the moment you reach in.

Figure 2. Dishmaker 1.0 showing variable pressure-mold (left) and various dishes (right).

Prototypes

First we demonstrated that a round disk of acrylic could be formed into a dish, plate bowl or cup. We did this by clamping an acrylic disk in a ring, heating it with a lamp and pressurizing it to blow a dish, bowl or cup in a pressure-forming system (see Figure 2). We sought a non-toxic material with a low softening point, and ended up with acrylic wafers. Acrylic and other amorphous polymers have "shape memory," meaning that under certain conditions the material returns to its original form. This property eliminates the need to melt the plastic, reducing the energy consumption dramatically. We proved the wafers could be recycled many times in a sandwich press under slight heat and pressure (see Figure 3). Our next goal was to make a system that would be computer-controllable allowing a dish-making interface

Figure 3. Recycling dishes in a sandwich press.