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# CRAFTED LOGIC

## Towards Hand-Crafting a Computer

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**Abstract**

This paper introduces the piece *Crafted Logic*, an interactive installation realized as part of a larger research into creating electronic components from scratch. The piece consists of fundamental logic gates that are created by various textile-crafting techniques. Each gate is composed of handcrafted relays that are controlled electromagnetically, and is capable of performing a different logical operation.

In replicating the basis of digital electronics in novel forms and through unconventional materials, our intention is to imagine alternatives to existing realities of computational technologies. *Crafted Logic* is a speculative artifact and process as means to reflect on the creation of digital systems that surround us, as well as on how this shapes our interaction with them.

**Author Keywords.**

Art; interactive; textile electronics; craft; computation; artistic research;

**ACM Classification Keywords**

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

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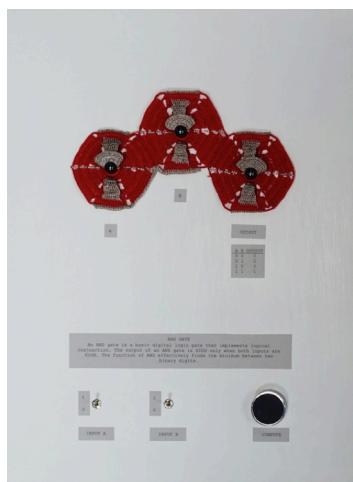


Figure 1: Crochet AND gate.

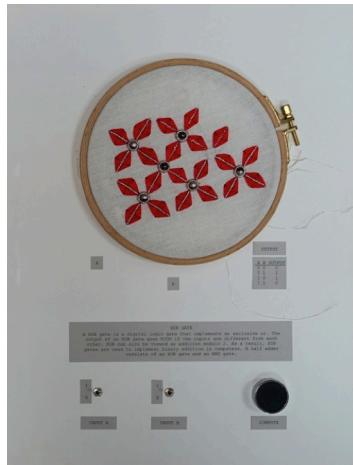


Figure 2: Embroidered XOR gate. Their original size can be seen in Figure 3.

### Artist's Statement

What if digital electronics emerged from textile handcrafts? How would technology be different if craftspeople were the catalyst to the electronics industry, via textiles manufacturing? *Crafted Logic* is an interactive piece, which consists of two interactive logic gates that are created from scratch by using conventional textiles hand-crafting techniques in combination with electronically active materials. The piece intends to provoke critique and discussion on the politics of technological invention and innovation.

Current industrial research is driven by the desire to invent the next killer application. Such research is often profit-oriented and is thereby concerned with the optimization of existing resources. This typically results in the employment of already well-established production procedures, hence affirms the societal favoring of particular personal skills, traits, qualifications, materials, investments and geographical locations over others. Artistic research, on the other hand, holds the chance to focus on implications rather than applications. Instead of introducing a new product that meets new buyers, this collaborative work explores new production procedures that call for new makers. In decisively employing people, materials, tools and techniques that have been uncharted, or left out of popular demand, *Crafted Logic* discloses resources other than 'the usual suspects' for computational creation, challenging our expectations about technology.

### Background and Idea

The combination of textile and computational elements has been the ground for many experiments and novel interactions in recent years. Most of them have utilized

the available variety of conductive threads for achieving lighter, softer and more flexible connections between the hard electronics and soft textile surfaces. Here, the field of textile electronics is taken one step further, focusing on the replication of the computational element per se through the means of textile crafts. The resulting speculative artifact, being at the same time a functional logic gate, aims at questioning the current way of interacting with electronic and digital objects, both in the way they are made and in the way they are used.

Logic Gates are the building blocks of digital electronics

1. As idealized or physical device implementing a Boolean function, a logic gate performs a logical operation on one or more logical inputs, and produces a single logical output. Every single digital device operates on some combination of the basic logic functions AND, OR and NOT, NAND, NOR, XOR and XNOR; even the most complex circuit can be reduced to them in the final analysis.

The *Crafted Logic* gates consist of handcrafted textile relays. A coil, wound of enameled copper wire, is integrated in the center of the craftwork. It acts as an electromagnet when under power. A magnetic hematite bead sits in the middle of the coil, turning with the changing polarity of the electromagnet 2. The bead has a crochet wing extension of conductive yarn in the crochet version 3 (Figure 1) and is half painted with conductive paint in the embroidery version 4 (Figure 2) in order to close an electrical contact and pass through the signal depending on the state of the relay<sup>1</sup>.

<sup>1</sup> More precisely a SPDT – Single Pole Double Throw relay where a common terminal connects to either of two others.



Figure 4: Detail view of a crochet element in state '0' with the crochet wing pointing down.



Figure 5: Detail view of a crochet element in state '1' with the crochet wing pointing up.



Figure 6: Detail view of the switches to set the input A and B, and button to compute the output.

All elements core to the function of the logic gate are visible on the front side. For aesthetic reasons the wiring is done in the back, invisible to the eye of the user. There are no other active or passive electronic elements on the backside.

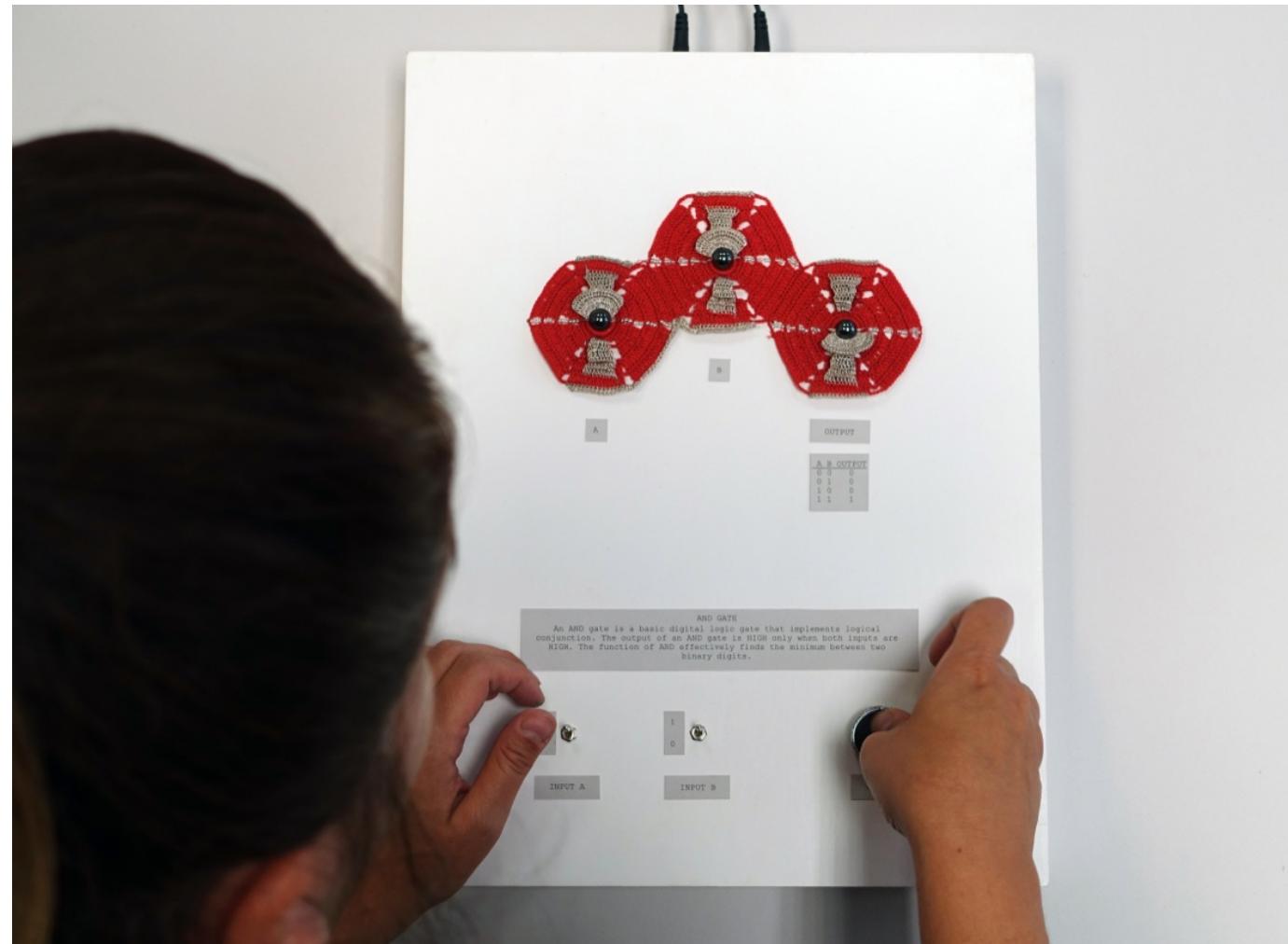


Figure 3: Interacting with the crochet AND gate. The switches on the bottom left side let the user set the input A and B to '0' or '1'. The button on the right side starts the computation process in supplying power to the crochet relay switches. The crochet elements on top display the set inputs for A (crochet on the left) and B (crochet in the middle) as well as the calculated output (on the right side). When interacting with the piece, the physical movement of the digital calculation can be observed.

□

**An AND logic gate**

implements a logical conjunction. The output of an AND gate is HIGH (1) only when both inputs are HIGH. The function of AND effectively finds the minimum between two binary digits.

Input A	Input B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Table 1: AND gate truth table.

A **XOR logic gate** is a digital logic gate that implements an exclusive or. The output of an XOR gate goes HIGH (1) if the inputs are different from each other. XOR can also be viewed as addition modulo 2. As a result, XOR gates are used to implement binary addition in computers. A half adder consists of an XOR gate and an AND gate.

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	0

Table 2: XOR gate truth table.

The crochet or embroidery unit may now represent one bit of a number, whether an event has occurred, or whether some action should be taken. It can become a part of a logic operation, an element of a display, or a storage element, among others.

In its function, *Crafted Logic* exemplifies the possibility to replicate a computer through the skills and materials embedded in the cultures of needlecrafts. In its appearance, in shifting the materials, skills and processes needed to create a basic logic function, it potentially opens new doors of thinking in diverse ways about the making of and interacting with computational systems. It challenges the aesthetics, interactions and technology creation scenarios we take for granted in the field today.

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**Artist Profile**

Ebru Kurbak is an artist, designer, educator and currently a principal investigator of an arts-based research project at the University of Applied Arts Vienna. She studied architecture at the Istanbul Technical University. She lectured at the Departments of Visual Communication Design at Istanbul Bilgi University and Space and Design Strategies at the University of Art and Industrial Design Linz. She has carried out artistic residencies at LABoral, V2\_ and Eyebeam and has shown her work at platforms such as Siggraph, Ars Electronica, ZKM, among others.

Irene Posch is a researcher and artist. Her practice deals with the integration of technological developments into the fields of art and craft and cultural and aesthetic implications thereof. She is a researcher at the University of Applied Arts Vienna and a PhD candidate at the Institute for Design and Assessment of Technology at the Vienna University of Technology. Her work has been presented at international platforms, among them FutureEverything (UK), Ars Electronica (AT), V2\_ Institute for the Unstable Media (NL), Eyebeam Art&Technology Center (NY), the Design Biennale St. Etienne (FR) and ZKM Center for Art and Media (DE).

Ebru and Irene currently collaborate on the artistic research project *Stitching Worlds* at the University of Applied Arts in Vienna: [www.stitchingworlds.net](http://www.stitchingworlds.net)

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