

# Haconiwa: A toolkit for introducing novice users to electronic circuits

Saki Sakaguchi   Sayaka Shimada   Nanae Shirozu   Mitsunori Matsushita  
Graduate School of Informatics, Kansai University  
Email: mat@res.kutc.kansai-u.ac.jp

**Abstract**—This paper proposes “Haconiwa,” a toolkit for learning how to build a basic electronic circuit intuitively. The toolkit is intended to motivate participants to develop an interest in electronic circuits. The toolkit aims at fostering the interest of participants in electronic devices and provides users with the pleasure involved in making products. The toolkit consists of two types of modules: basement modules and object modules (e.g., LED, battery, and switch). Users can customize the appearance of the object modules by decorating them with fancywork. By connecting the decorated modules with the basement modules, users can make their own original miniature scenery.

## I. INTRODUCTION

The goal of this research is to motivate novice users to develop an interest in electronic devices. To aid motivation, we employ the concept of “techno-handicraft (Tekuno-Shugei in Japanese).” Techno-handicraft is a physical computing paradigm that combines fancywork (e.g., needle felting and stuffed toy making) with popular material and electronic handicraft with electronic devices. Techno-handicraft intends to provide a novel handicraft experience to novice users.

Based on this concept, this paper proposes a toolkit for electronic toy production. The target user of the proposed toolkit is a person who has not had the chance to make electronic handicrafts and engage in physical computing. The motivational characteristic of the toolkit is the option to use fancywork to learn about electronic circuits, because the target users are expected to be familiar with fancywork.

## II. HACONIWA DESIGN

The objective of Haconiwa is to enable a user to build simple electronic circuits, such as a small illuminating or singing character, without excessive burden. A Haconiwa user can make a miniature scenery by connecting various types of modules, which together form an electric circuit if correctly connected. This mechanism intends to help a user understand how a circuit should be formed, through a trial-and-error process. We assume that such an experience will help naturally foster a user’s interest in electronic circuits and devices. The toolkit consists of two types of modules: basement modules and object modules.

A Basement module of Haconiwa is a module that serves as a physical platform. As a conducting wire is present inside a basement module, a circuit is formed when a set of basement modules is connected.

Object modules are used to connect the basement modules. In each object module, some electronic device, such as an LED and sound IC with small speaker, is installed inside. Therefore, these object modules can provide dynamic expressions, such as light illumination and sound production, if a circuit consisting

of them is correctly formed. The appearance of the object can be customized using handicraft material. Thus, users can decorate the objects as per their own preferences. It is expected that a user would enjoy not only the output result, (i.e., the accomplished scenery) but also the process of making the scenery. Such an experience aids in learning how to make a circuit subjectively in an enjoyable manner.

As for the material of the conducting wire used in the basement modules, conductive threads are used that can carry current in the same manner as metal wires. By using conducting wires, the basement module becomes soft and flexible, and is devoid of hardness typically specific to electronic components.

For the connection terminal, a snap button commonly used as a handicraft material is employed. Therefore, even if the user is a small child, he/she can create a circuit safely, without a need to solder electronic components.

## III. IMPLEMENTATION

### A. (1) Basement module

A basement module functions as a connecting wire. This module is made using a square felt of size 65 mm × 65 mm. Snap buttons made of metal are attached onto it and are stitched using conductive threads. There are three types of basement modules: line type, corner type, and T-type (see Fig. 2.2). On the surface of the basement module, road patterns made of felt material are attached in accordance with the wire pattern. This road is an indicator of the wire pattern inside the basement module. This arrangement helps a user visually discriminate wire patterns.

### B. (2) Object module

An object module has two roles: connecting two basement modules and serving as an input or output device. There are four types of objects: LED, battery, switch, and connector (See Figure 2). In each object module, a functional accessory is attached onto the object’s base.

The object’s base is made of a circular felt of diameter 35 mm. As the functional accessory, electronic devices for input or output (i.e., LEDs and sound IC with small speaker unit) are attached onto the object’s base. In addition, snap buttons made of metal are attached onto the object’s base with connecting thread. In the following, we briefly explain each object.

Regarding the connector object, the road made of felt material is attached, which is similar to the basement module. The leftmost column in Figure 2 shows an example of the connector object.

Regarding the LED object, two LEDs, for instance, are installed inside the object in parallel. Second figure from the left in Figure 2 shows the initial stage of the LED object. Accordingly, a user can decorate textures to form preferred objects such as animals and buildings. It allows users to create original LED objects without requiring to solder electronic materials.

Regarding the switch object, a button for needlecraft is attached. The button can be used as a switch. When a user pushes the button, the switch changes to the on state. The second figure from the right in Figure 2 shows an example of the switch object.

Regarding the battery object, a pond and a bridge are decorated on the object's base. The rightmost column in Figure 2 shows an example of the battery object.

A user can discriminate the roles of these objects easily by glancing at the decoration.

Each kit has 18 basement modules, 2 LED objects, 2 battery objects, 2 switch objects, and 12 connector objects. By using these objects, a user can construct two circuits. One is a series circuit that can illuminate a single LED object, and the other is a parallel circuit that can illuminate two LED objects.

#### IV. HOW TO MAKE A HACONIWA SCENERY

There are two steps to create a Haconiwa scenery: (1) form a circuit by arranging the basement modules, (2) place objects to connect the basement modules.

To avoid wrong connections, a convex-type snap button is sewn onto the basement module with conductive thread, and a concave-type snap button is sewn onto the objects with conductive thread. A user can make his/her own original scenery by connecting these basement modules and object modules.

To enhance the attractiveness, objects for decoration that do not have any electronic function are prepared. Following are examples of such objects, wood and an animal made of needle felt. Figure 3 shows an example of a scenery created with the Haconiwa toolkit. These objects are intended for the blank spaces of the basement modules. By placing these objects, the appearance of the scenery turns into gaiety.

#### V. SUPPLEMENTAL MATERIAL: REFERENCE CARD FOR PROVIDING INSTRUCTIONS

When learning electronic handicraft, supplemental material for self-learning is desired [1]. To meet such a requirement, we designed a set of supplemental cards that intends to help a novice user of electronic handicraft to understand how to use Haconiwa objects. Figure 4 shows an example of the supplemental cards.

In each card, the name of the object, photograph of appearance, circuit symbol, explanation, and cautionary statement are provided. A user can refer to information selectively catering to his/her level of knowledge and necessity. Each card can be used separately. In addition, by placing the cards in a card pocket with an index, they can also be used as a tabulated manual for holistic viewing. By using the cards, it is expected that

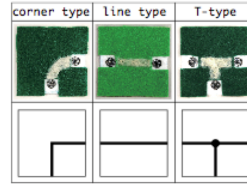


Fig. 1. Basement modules

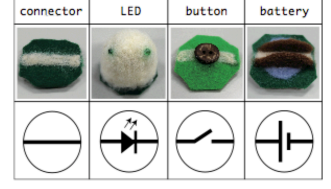


Fig. 2. Object modules



Fig. 3. Haconiwa scenery example Fig. 4. Reference card

users easily understand the function of an object and related precautionary statements.

When a hands-on workshop is conducted with the Haconiwa toolkit, a workshop instructor can use the cards for providing instructions.

At present, we only created cards for explaining the function of the modules. In the future, we will create variations of the cards; for example, cards that explain the theory of electronics (e.g., mechanism of LED, difference between a parallel circuit and a series circuit). In addition, we will develop some game rules and list them on the cards to enhance the incentive for learning electronics.

#### VI. CONCLUDING REMARKS

This paper proposed Haconiwa, a toolkit for a novice user to learn how to build a basic electronic circuit intuitively. The main contribution of this paper is not an invention of a novel technology but a design practice of a toolkit that is intended for novice users that are unfamiliar with electronics and electronic handicraft, particularly younger kids.

Future work includes extending available object modules to perform various functions. Further, in order to motivate a user to create more creative Haconiwa sceneries, the type of object modules should be increased. It is also expected that the interactivity of Haconiwa can be improved if object modules with various sensors and micro controllers are developed. Fabric sensors that offer soft, customizable, and affordable use are preferred for engaging participants [2,3].

#### REFERENCES

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